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POLLUTANT EMISSION FACTORS FOR GAS STOVES: A LITERATURE SURVEY

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16. ABSTRACT Published emission factors for CO, NO, NO2, and NOx for gas-fired kitchen stoves have been summarized. Analysis of variance was then used to investigate the importance of three binary factors: burner position, sampling method, and type of combustion. The first two factors were relatively unimportant in explaining the observed variance for the four pollutants. However, roughly 50% of the observed variance in log EF (base 10 logarithm of the emission factor) for CO, 30% of that for NO2, and a fraction of that (from 0.088 to 0.56) for NO and NOx can be explained by the type of combustion. Multivariate regression test results showed that stove differences were significant at the 95% level in explaining the variance in CO, NO2, and NOx emission factor. Type of combustion was significant for CO, NO, and NO2. Burner position had a smaller, but statistically significant, effect in explaining the variance in CO and NO2 emissions. The method of sampling had a small, but statistically significant, effect for NOx emissions. Plots of data showed that CO and NO2 emissions vary considerably with gas flow rate, while NO and NOx emissions are less variable.

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Abstract

Published emission factors for CO, NO, NO_2, and NO_x have been summarized. In a statistical analysis of the available data, stove differences and type of combustion are the most important factors in explaining the observed variance in emission factors. Limited data also suggest that CO and NO_2 emission factors vary considerably with gas flow rate. It is concluded that the influence of stove design, gas flow rate, and characteristics of stove use are key factors which merit further study.

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EXECUTIVE SUMMARY

Published emission factors for CO, NO, NO_2, and NO_x for gas-fired kitchen stoves have been summarized. To the extent that data exist, the emission factors have been used in a statistical analysis to investigate the most important factors influencing emissions.

First, the data were used to construct normal probability and log probability plots based on the cumulative distribution of the emission factors. Correlation coefficients were computed for both types of plots. Results showed that the log probability plot provided a better fit to the CO and NO_2 data with reasonably high correlation coefficients, suggesting that the emission factors for these pollutants may be approximated by lognormal distributions. Either normal or lognormal distributions were satisfactory for NO and NO_x. For consistency, the emission factors for all four pollutants were assumed to be distributed lognormally in subsequent analysis.

Analysis of variance was then used to investigate the importance of three binary factors in explaining the observed variations in emissions. The factors considered were (1) type of combustion (poorly adjusted or well adjusted), (2) burner position (front or rear), and (3) method of sampling (direct or indirect). The results showed that roughly half of the observed variance in log EF (base ten logarithm of the emission factor) for CO can be explained by noting whether the combustion is poorly adjusted or well adjusted. For NO_2, roughly one-third of the variance can be explained by this factor. For NO and NO_x, the fraction of variance explained by this factor depends upon the subset of the data chosen: fractions ranged from 0.088 to 0.56. Burner position and method of sampling were both relatively unimportant in explaining the observed variance for any of the four pollutants.

The emission factor data were then used to estimate coefficients in various multivariate regression models. The first regression model incorporated several factors: type of combustion, burner position, method of sampling, the three two-way interactions among these factors, and (M-1) binary factors corresponding to the M stoves for which data were available (M= 27, 26, 26, and 8 for CO, NO, NO_2, and NO_x, respectively). Subsequent multivariate regression models were constructed by sequentially eliminating a factor or factors from the previous model. Results of these tests showed that stove differences were significant at the 95% level in explaining the variance in CO, NO_2, and NO_x emission factor. Type of combustion was significant for CO, NO, and NO_2. Burner position had a smaller but still statistically significant effect in explaining the variance in CO and NO_2 emissions. Similarly, the method of sampling had a small but statistically significant effect for NO_x emissions.

The influence of gas flow rate on emission factors was investigated separately. Statistical tests were not run for this factor due to lack of data and due to the presence of detailed

data from only one study. Results of plotting all of the data for each pollutant on a common graph showed that CO and NO_2 emissions vary considerably with gas flow rate, while emissions of NO and NO_x are less variable.

The data were used to investigate the sensitivity of predicted airborne concentrations to uncertainties in emission factors. The solution of a one-compartment mass balance model was used as the predictor of concentration. For the existing distribution of emission factor data, the current uncertainty in CO is responsible for a larger fraction of the variance in predicted concentration than uncertainty in air exchange rate. For NO and NO_2, however, the uncertainty in air exchange rate is more important than the emission factor uncertainties.

Finally, the data were used to identify critical gaps in our understanding of emission factors and to suggest future experiments. Overall, it is concluded that the influence of stove design, gas flow rate, and characteristics of stove use are key factors which merit further study.

I. INTRODUCTION

Attempts to model or to predict air quality in residences are often hampered by the complexity of factors influencing indoor pollution concentrations. Of particular concern is our limited understanding of emission rates from indoor sources. Gas appliances, kerosene heaters, consumer products, tobacco, and building materials each emit a wide variety of pollutants; the rates of emission are unknown functions of source characteristics, environmental parameters, and use patterns. The current literature contains data on pollutant emission rates from such sources for specific conditions during testing (National Academy of Sciences, 1981; Cole and Zawacki, 1985). However, the extent to which these data can be applied to real-world situations has not been thoroughly investigated.

One important source of CO, NO, and NO_2 in many residences is the combustion of natural gas. Appliances using gas include kitchen stoves, furnaces, water heaters, dryers, and space heaters. Kitchen stoves are among the most important sources, since emissions from the other appliances are often vented to the outside.

This study addresses problems in using currently available emissions data for kitchen stoves in indoor air quality models. The pollutants of primary concern are CO, NO and NO_2. The project includes several topic areas.

First, existing data reported in the literature for emissions from range-top burners of kitchen stoves are summarized. Wherever possible, these data are used to examine the influence of various parameters on the measured emissions.

Second, the existing data are evaluated to assess the extent to which the emission factors can be used in current indoor air quality models.

Finally, the results of the evaluation are used to identify critical gaps in our knowledge of emissions from kitchen stoves. These findings are then used to suggest topics of future research to provide the data needed for more accurate assessment of pollutant concentrations in residences.

II. SUMMARY OF EXISTING DATA

This section summarizes currently available information on emission factors for gas-fired stoves. The sources of information for the section are discussed first. Experimental methods used to estimate emission factors are then presented. Next, emissions data are listed for each set of measurements for which information is available. Analysis of variance and multivariate regression techniques are then used to investigate the influence of various factors on emissions. Finally, the influence of gas flow rate on emission factors is considered.

Sources of Information

Information on experimental methods and measured emission factors has been taken from several sources. Journal articles and published conference proceedings provided brief summaries of the techniques used to generate the emissions data and values of the emission factors in several cases. Additional information was obtained from reports issued by the American Gas Association Laboratories, the Institute of Gas Technology, and the Gas Research Institute. Information was also obtained from presentations and discussions with participants at four workshops:

1. Indoor Air Quality Modeling Workshop, February 11, 1985, Gaithersburg, MD, sponsored by the National Bureau of Standards.

2. Workshop on Unvented Space Heater Consensus Test Procedures for Determining Emission Rates, May 2, 1985, Chicago, IL, sponsored by the Gas Research Institute.

3. Workshop on Characterization of Contaminant Emissions from Indoor Sources, May 13-15, 1985, Chapel Hill, NC, sponsored by the Air and Energy Engineering Research Laboratory, U.S. Environmental Protection Agency.

4. Symposium on Indoor Air Studies, May 21-23, 1985, West Long Branch, NJ, sponsored by the American Chemical Society.

Most of the research groups in the U.S. investigating pollutant emissions from gas-fired stoves were represented at one or more of these meetings.

The original plan for the principal investigator (PI), Dr. Cliff Davidson, to visit the laboratories of at least two research groups was modified in the course of the research; instead, the PI attended the first three workshops while John Borrazzo (the Graduate Research Assistant supported by the project) attended the fourth workshop. Attending these meetings provided opportunities to discuss methods of source sampling and to exchange ideas on ways of using the data in air quality models with many of the researchers active in the field. This was deemed superior to the benefits of visiting only a limited number of laboratories.

Table 1 lists the primary references for those emission factor data obtained at high gas flow rates of 138-210 kJ/min. Emission factor data reported by Yamanaka et al. (1979) and Caceres et al. (1983) were not included because the composition of the fuels was different from that commonly used in the U.S. The table shows the number of stoves, total number of burners, and total number of observations given in each reference. The number of observations refers to the number of separate emission factors cited. In one case, data from two burners were averaged to give a single emission factor; in all other cases, there is at least one emission factor cited per burner. Because some of the cited emission factors are

averages of several tests, where the individual data from each test were not given in the original reference, the overall total number of tests is also provided where available. Finally, the table includes the experimental method used (see following section) and the pollutants reported. Emissions of SO_2, particles and trace organics are also given in some of these references, although this information will not be considered in the scope of the present study. Note that Himmel and DeWerth tested 18 stoves; half were designed to operate at a maximum of 160 kJ/min while the other half were designed to operate at a maximum of 210 kJ/min. Because the emission factors were not identified with either of these categories, all data were assumed to be at 160 kJ/min in the analysis reported below.

Experimental Methods

There are two categories of experimental procedures which have been used to measure emissions from range-top burners. These include direct sampling with a hood placed over the burner, and indirect sampling with the entire stove placed in an environmental chamber.

Direct Sampling

Direct sampling has been conducted by Himmel and DeWerth (1974), Cole et al. (1983), Massachusetts Institute of Technology (1976), Fortmann et al. (1984) and Borrazzo et al. (1986). Himmel and DeWerth (1974) tested each of four burners on 16 commercial stoves and three burners on two additional stoves. A quartz sampling hood was positioned as shown in Figure 1a. The combustion exhaust gases were then drawn through the top of the hood, passed through a cold trap to reduce moisture content, and directed into pollutant analyzers. These investigators used the standard ANSI pot filled with water as a load. The ANSI pot is chrome-plated brass, having dimensions 18.9 cm in diameter by 15.2 cm high. The quartz hood was positioned over the burner and pot such that the CO_2 concentration in the emissions is approximately 2%. This value was selected to provide a reasonably concentrated sample which did not have an excessive correction factor when calculating the air-free pollutant concentration:

$$\text{Air-Free Pollutant Concentration} = \frac{\text{Ultimate } CO_2}{\text{Sample } CO_2} \times \text{Sample Pollutant Concentration} \quad (1)$$

Ultimate CO_2 refers to the concentration expected based on stoichiometric considerations. The combustion process was allowed to reach steady-state before recording data.

Cole et al. (1983) used the same experimental set-up as Himmel and DeWerth (1974) to test three commercial stoves. The four burners on each stove were sampled separately. As with Himmel and DeWerth, these investigators operated the burner until steady-state was achieved,

and reported their data for steady-state conditions. Equations similar in principle to but more refined than those used by Himmel and DeWerth (1974) were developed for calculating emission factors. The data of Cole et al. can be found in the report by Moschandreas et al. (1985).

Tests conducted by the Massachusetts Institute of Technology (1976) involved one burner on one stove. Because no load was used, the results may not be representative of emissions with a cooking utensil in place.

Tests conducted by Fortmann et al. (1984) involved use of sheet metal hood covering all four burners on each of two stoves, following procedures established by Yamanaka et al. (1979). Each burner was sampled separately. A water-filled stainless steel pot with dimensions 22 cm in diameter by 17 cm high was used as the load. Because of a relatively high fraction of dilution air in the exhaust gases, humidity levels in the effluent did not approach saturation and use of a cold trap was not necessary for these experiments. Tests at various dilution air flow rates verified that combustion conditions were not appreciably altered by the presence of the sampling system. Pollutant sampling was conducted only at steady-state. A diagram of the system is shown in Figure 1b.

Finally, Borrazzo et al. (1986) used a Teflon-coated stainless steel hood to sample a single burner on one of the two stoves previously investigated by Fortmann et al. (1984). The dilution airflow system and the water-filled stainless steel pot were the same as those used by Fortmann et al. (1984). The hood was positioned 2.5 cm above the surface of the stove. Tests were conducted during initial start-up of the appliance as well as at steady-state.

Indirect Sampling

Several investigators have placed their stoves into environmental chambers to estimate emissions. The stove is operated under normal conditions while pollutant concentrations and chamber air exchange rates are monitored. A one compartment mass balance model is then used to calculate the emission factors resulting in the observed pollutant concentrations in the chamber. This approach has been used by Cote et al. (1974), Traynor et al. (1982a) and Moschandreas et al. (1985).

The tests of Cote et al. (1974) involved one burner from each of two stoves. An 8.0 m^3 chamber was operated at 64 air changes per hour (ACH) for these experiments.

Traynor et al. (1982a) tested two burners on one stove. A chamber of volume 27 m^3 with air exchange rates of 0.24-0.42 ACH was used.

Finally, Moschandreas et al. (1985) tested one burner on each of three stoves. Their chamber had a volume of 33 m^3 operated at air exchange rates of 1-5 ACH.

Presentation of Emission Factor Data

The original data from the references of Table 1 are given in Appendix A. These emission factors have been summarized to determine whether the data for each pollutant follow a normal distribution or a lognormal distribution. For this analysis, the data have been categorized according to three separate factors:

a) Burner position - front or rear
b) Method of sampling- indirect or direct
c) Type of combustion - poorly adjusted (yellow flame)
or well adjusted (blue flame).

Other factors, such as burner design, air temperature, and relative humidity may also influence emissions. Unfortunately, information on factors other than the three listed above was generally not available in the references of Table 1. A limited amount of information on gas flow rate was available, however; this variable will be considered separately below.

Based on the three factors above, several categories consisting of various combinations of the available data were constructed. These categories include the following:

All Data
All Rear (Direct and Indirect, Poorly and Well Adjusted)
All Front (Direct and Indirect, Poorly and Well Adjusted)
All Indirect (Front, Poorly and Well Adjusted)
All Direct (Rear and Front, Poorly and Well Adjusted)
All Direct Front (Poorly and Well Adjusted)
All Direct Rear (Poorly and Well Adjusted)

All Poorly Adjusted Combustion Data
Poorly Adjusted Rear (Direct and Indirect)
Poorly Adjusted Front (Direct and Indirect)
Poorly Adjusted Indirect (Front)
Poorly Adjusted Direct (Rear and Front)
Poorly Adjusted Direct (Front)
Poorly Adjusted Direct (Rear)

All Well Adjusted Combustion Data
Well Adjusted Rear (Direct and Indirect)
Well Adjusted Front (Direct and Indirect)
Well Adjusted Indirect (Front)
Well Adjusted Direct (Rear and Front)
Well Adjusted Direct (Front)
Well Adjusted Direct (Rear)

Note that the indirect data available was obtained using front burners, if burner position was specified. Hence, subclassification of the indirect emission factors is not possible.

For each of the 21 categories, the data were used to construct normal probability and log probability plots based on the cumulative frequency of emission factors. These graphs were constructed for CO, NO, NO_2, and NO_x, providing a total of 168 plots. Some of the distributions were based on limited data, however, due to the small number of measurements in a few of the categories. In each case, the data subsets were used to estimate values of arithmetic mean and standard deviation, geometric mean and standard deviation, and correlation coefficient r for assumed normal and lognormal distributions.

The values derived from each plot are summarized in Tables 2a–d. As examples, plots for the All Data, All Poorly Adjusted Combustion Data, and All Well Adjusted Combustion Data for each pollutant are included in Appendix B. Each plotted point represents one observation; as discussed earlier, some observations represent averages of a number of individual tests. The number of observations in a given category does not necessarily equal the sum of the observations in all of its component subcategories, due to incomplete information on the three factors in some of the datasets.

The results in Tables 2a–d can be used to determine whether a normal distribution or a lognormal distribution assumption represents a better fit to the data. The estimator of the correlation coefficient r for the normal probability plot represents a goodness of fit indicator for the normal distribution, while the estimator for r for the log probability plot represents a goodness of fit indicator for the lognormal distribution.

The data for CO and NO_2 show greater values of r for the lognormal distribution for most categories of data. There is very little difference in values of r for NO_x, suggesting that it is difficult to distinguish between normal or lognormal distribution assumptions. For NO, the values of r in most categories are only slightly greater for the normal distribution.

With the exception of relatively small values of r for the normal distribution for CO, the correlation coefficients are generally greater than 0.95 for both normal and lognormal distributions for all categories and pollutants. For consistency with the CO data, a lognormal distribution has been chosen as the best-fit to the data overall. The analysis of variance and linear regressions discussed in the next section have thus been applied to the base ten logarithm of the emission factors (log EF).

Analysis of Variance

Several of the data subsets have been used to investigate the importance of each of the three factors above in explaining the observed variations in emission factors. A one-way analysis of variance has been applied. The coefficient of determination r^2 for each category of data represents the fraction of total variance in log EF which can be explained by the

factor being tested. Note that each of the three factors is binary; results of these analyses allow comparison of the mean value of log EF for each level of a given factor.

Results are shown in Tables 3a–c. For CO, roughly 40–60% of the observed variance in log EF can be explained by noting whether the combustion is poorly adjusted or well adjusted. For NO_2, roughly one-third of the variance can be explained by this factor. Values of r^2 for NO and NO_x vary from 0.088 to 0.56.

In contrast, Table 3b suggests that the Burner Position factor is relatively unimportant in explaining the variance of log EF. Values of r^2 vary from 0.002 to 0.06, all relatively small. Himmel and DeWerth (1974) similarly investigated the influence of burner position on their emission factors, which they suspected may be important due to differences in secondary air flow in the combustion process. Their findings showed only a very small effect of burner position, in agreement with the results in Table 3.

Finally, the Method of Sampling factor in Table 3c is also relatively unimportant in explaining log EF. Values of r^2 vary from 0 to 0.06 for CO, NO, and NO_2. The large values of r^2 for NO_x are probably due to a smaller sample of stoves reporting the NO_x values relative to the sample sizes for CO, NO, and NO_2.

The data in Tables 3a–c can be used in two ways to test the null hypothesis:

H_o: The factor under examination is not significant at the 95% confidence level.

The first involves constructing 95% confidence intervals based on the t-distribution for the means of values at the two levels of each factor. This is shown graphically in Tables 3a–c. If the difference of means is not significantly different from zero, then H_o cannot be rejected. An equivalent second test utilizes the r^2 value in the F-test on the significance of the variance explained by the factor. The relevant F-statistic in this case is:

$$F = (n_1 + n_2 - 2) \times \frac{r^2}{1-r^2} \qquad (2)$$

where r^2 is obtained from Tables 3a–c and n_1 and n_2 are the number of observations associated with the two levels of the factor being tested. If F is less than the 95% point of an F distribution with the same number of degrees of freedom, i.e. $F_{1,\, n_1 + n_2 - 2;\, 0.05}$, then H_o cannot be rejected. If a factor was not significant at the 95% confidence level but was significant at the 90% level, this is also indicated in Tables 3a–c.

Multivariate Regression Analysis

For each pollutant, all available data were utilized in estimating coefficients for various multivariate regression models. The first regression model included the following factors: Burner Position, Method of Sampling, Type of Combustion, the three two-way interactions among these factors, and (M-1) binary factors corresponding to M stoves. (M= 27, 26, 26, and 8 for CO, NO, NO_2, and NO_x, respectively). The factors corresponding to the stoves are collectively referred to as "Stove Differences." An attempt was made to include research group as an additional factor; however, this was confounded by Stove Differences, since in only one case did two research groups test the same stove. Consequently, differences in emission factors by stove in this analysis may represent in part differences in experimental procedures among research groups.

Subsequent multivariate regression models were constructed by sequentially eliminating a factor or factors from the previous model. An F-test was performed to examine whether the eliminated factor or factors were significant in explaining the variance in the dependent variable, log EF. The null hypothesis is:

> H_o: The factor or factors are not significant, i.e. the corresponding regression coefficient or coefficients are not significantly different from zero.

The F-statistic was calculated from the coefficients of determination for regressions with and without the factor being tested. If the F statistic is less than the 90% point of an F-distribution with the same number of degrees of freedom, then the null hypothesis cannot be rejected at the 90% confidence level. This test was performed at the 90% and the 95% levels.

Results of these analyses are shown in Tables 4a-d. Stove Differences were significant at the 95% level in explaining the variance in CO, NO_2, and NO_x emission factor. Type of Combustion was significant at the 95% level for CO, NO, and NO_2 but not for NO_x. This is reasonable because the data in Table 3a indicated that Type of Combustion tends to have counteracting effects on NO and NO_2. Emissions of NO are greater for well adjusted combustion, while emissions of NO_2 are greater for the poorly adjusted case. Burner Position had a smaller but still statistically significant effect in explaining the variance in CO and NO_2 emissions, and the same can be said for Method of Sampling with respect to NO_x emissions.

Influence of Gas Flow Rate on Emission Factor

Gas flow rate has been considered separately from the other factors due to the limited data available, and due to the dominance of emissions from only one study. Figures 2a-d show

emission factor as a function of gas flow rate for the four pollutants of interest. The four studies providing data for these Figures are summarized in Table 5, while the original emission factor data are given in Appendix C.

Most of the data are from the study of Borrazzo et al. (1986), which included detailed measurements at a number of gas flow rates. The data of Fortmann et al. (1984) pertain to an older cast-iron stove; note that the emissions of CO and NO_2 are considerably different for this stove compared with the other data available.

No attempt has been made to develop mathematical models for emission factor versus gas flow rate from these data. Considerably more information from a variety of stoves operated at a number of gas flow rates would be needed for model development. This is discussed in the final section.

III. USE OF EMISSION FACTOR DATA IN INDOOR AIR QUALITY MODELS

The principal reason for generating the emission factors summarized in Appendices 1 and 3 is for use in predicting indoor air quality. This section is concerned with assessing the utility of the emission factor data in such models. The models most commonly used for predicting indoor airborne concentrations are discussed first. Two studies represented in Table 1 which used their emission factors for concentration modeling are described next. Finally, the sensitivity of predicted indoor concentrations to uncertainties in emission factors is discussed.

Models of Indoor Air Quality in Residences

The most commonly used mathematical model is the single compartment mass balance, assuming complete mixing throughout the house:

$$V \frac{dC}{dt} = q' (1-F') C' - (q'+kV) C + S_{bk} + S \qquad (3)$$

with initial condition $C(t=0) = C_o$

where

- V = volume (m^3)
- C = pollutant concentration ($\mu g/m^3$ or ppm)
- q' = infiltrating airflow (m^3/hr)
- C' = outdoor concentration ($\mu g/m^3$ or ppm)
- F' = fraction of material lost by deposition or reaction during transport from outside to inside
- k = loss rate coefficient (hr^{-1})

S_{bk} = background source emissions (μg/hr or ppm-m^3/hr)

S = appliance source emissions (μg/hr or ppm-m^3/hr)

S_{bk} is assumed to consist solely of emissions from the pilot lights which burn continuously in the gas stove.

With the exception of the source emissions term, it is assumed that all model parameters are constant over the time interval of interest. For S, an initial deviation from steady-state can be accounted for by assuming S can be of the form:

$$S(t) = S_{ss} + (S_o - S_{ss})\, e^{-bt} \qquad (4)$$

where

S_{ss} = steady-state source emissions (μg/hr or ppm-m^3/hr)
S_o = initial source emissions (μg/hr or ppm-m^3/hr)
b = fitted from transient emissions test data (hr^{-1})

If the background and steady-state concentrations are denoted by C_{bk} and C_{ss}, respectively, it follows that

$$C_{bk} = \frac{q'\ (1-F')\ C' + S_{bk}}{q' + kV} \qquad C_{ss} = \frac{q'\ (1-F')\ C' + S_{bk} + S_{ss}}{q' + kV} \qquad (5,6)$$

Note that if steady-state with respect to the background is achieved prior to the start of an experiment, C_o should equal C_{bk}. A simple transformation to dimensionless concentration ψ and dimensionless time τ allows comparison of model predictions with observations for different values of the dimensional model parameters:

$$\psi = \frac{C - C_{bk}}{C_{ss} - C_{bk}} \qquad \tau = \left(\frac{q'}{V} + k \right) t \qquad (7,8)$$

Thus, ψ represents the fraction of steady-state concentration achieved, corrected for a background bias. τ measures time relative to the characteristic time constant for concentration decay. With these substitutions for C and t, the differential equation for $\psi(\tau)$ is

$$\frac{d\psi}{d\tau} + \psi = \begin{cases} 1 + \gamma e^{-\beta\tau}, & \tau \leq \tau_b \\ 0, & \tau > \tau_b \end{cases} \quad , \quad \tau_b = \left(\frac{q'}{V} + k \right) t_b \qquad (9)$$

where

$$\gamma = \frac{S_o - S_{ss}}{S_{ss}}$$

$$\beta = \frac{b}{q'/V + k}$$

and t_b is the length of time for which the appliance is operated, measured from t=0. Note that in the case where S_o equals S_{ss}, γ is zero and the second term on the right side of the equation vanishes.

The solution to this equation is simply:

$$\psi = (1-e^{-\tau}) + \psi_o e^{-\tau} + \frac{\gamma}{1-\beta}(e^{-\beta\tau} - e^{-\tau}) \qquad \text{for } \tau \leq \tau_b \quad (10a)$$

$$\psi = [(1-e^{-\tau_b}) + \psi_o e^{-\tau_b} + \frac{\gamma}{1-\beta}(e^{-\beta\tau_b} - e^{-\tau_b})]\, e^{-(\tau-\tau_b)} \qquad \text{for } \tau > \tau_b \quad (10b)$$

where $$\psi_o = \frac{C_o - C_{bk}}{C_{ss} - C_{bk}}$$

Through the above procedure, the number of model parameters has been reduced. Note that if ψ_o and γ are zero, the resulting curve of ψ versus τ depends only upon the value of τ_b.

For situations where complete mixing cannot be assumed, a multi-compartment mass balance model may be appropriate. The relevant equations for two compartments are:

$$V_u \frac{dC_u}{dt} = q'_{ou}(1-F_u')C' + q_{du}C_d - (q'_{uo} + q_{ud} + k_u V_u)C_u \qquad (11a)$$

$$V_d \frac{dC_d}{dt} = q'_{od}(1-F_d')C' + q_{ud}C_u - (q'_{do} + q_{du} + k_d V_d)C_d + S_{bk} + S \qquad (11b)$$

with initial conditions

$C_u(0) = C_{u_o}$ and $C_d(0) = C_{d_o}$

where subscript "u" refers to the upstairs compartment

subscript "d" refers to the downstairs compartment

q'_{ou} = infiltrating airflow to the upstairs compartment (m^3/hr)

q'_{uo} = exfiltrating airflow from the upstairs compartment (m^3/hr)

q'_{od} = infiltrating airflow to the downstairs compartment (m^3/hr)

q'_{do} = exfiltrating airflow from the downstairs compartment (m^3/hr)

q_{ud} = intercompartmental airflow from upstairs to downstairs (m^3/hr)

q_{du} = intercompartmental airflow from downstairs to upstairs (m^3/hr)

The solution to this set of equations has been published by the National Academy of Sciences (1981).

In residences where mixing is relatively rapid and essentially complete, the one-compartment model is usually adequate for time scales greater than the characteristic mixing time.

Use of Emission Factor Data in One Compartment Mass Balance Models

Several studies have estimated pollutant concentrations using equation 3 above, and have compared these results with measured concentrations in residences. However, only two such studies have used values of S obtained from the same gas stove which was operated in the residence during the indoor concentration measurements. The results of these two studies are of importance to the objectives of the present project: discrepancies observed in the studies may establish lower bounds to uncertainties expected when predicting concentrations in residences where the stove emissions are unknown. The results of the studies will now be discussed.

Study of Traynor et al. (1982b)

These investigators placed their gas stove in the kitchen of a one-story 260 m^3 experimental house (see Figure 3) and measured concentrations of CO, CO_2 and NO_x during operation of the

stove. The main purpose of their study was to investigate the effect of ventilation rate on indoor concentrations of these pollutants. Two types of ventilation were considered: a whole-house mechanical system incorporating a heat exchanger, and a ventilation fan installed on the stove. Pollutant concentrations were compared with one compartment mass balance model predictions for operation of each ventilation system as well as when neither system was operational. The stove was operated according to the cycle shown in Figure 4.

For tests where neither ventilation system was used and for tests involving whole-house ventilation, all of the stove emissions were assumed to enter the living space of the house. Thus the values of S in equation 3 were taken directly from the results of emission factor tests in the environmental chamber (Traynor et al., 1982a) shown in Figure 4. For tests involving operation of the ventilation fan on the range, the source strength was considered a variable since a significant fraction of the emitted gases was drawn directly into the exhaust vent. For all of these tests, the decay of stove-generated CO was used as a tracer gas to estimate the air exchange rate q'/V in equation 3. The loss rate coefficient k was assumed to be zero for CO, and was estimated for NO_x based on comparing the rate of decay of NO_x with that of CO.

Results are shown in Figures 5a, b and c. Figure 5a compares model predictions with experimental results for CO in the absence of mechanical ventilation, while Figure 5b provides the same comparison for whole-house ventilation for CO and NO_x. Figure 5c shows the experimental data for NO_x operation of the ventilation fan on the stove.

These graphs show the influence of ventilation system on the resultant pollutant concentrations. Whole-house ventilation is clearly much less effective than a ventilation fan on the hood, since the latter removes exhaust gases before they can enter the living space. An increase in whole-house ventilation from 0.3 to 0.83 ACH reduces peak CO levels by a mere 20%. This is because the initial increase in CO occurs over a time period much shorter than the time constant for air exchange; indoor CO concentrations are thus determined mostly by the source strength S. The influence of q'/V becomes more significant as time increases.

Of primary interest to the present study is the agreement between measured and modeled concentrations. Traynor et al. (1982b) estimated the peak pollutant concentrations of CO, CO_2 and NO_x, which occurred at the time the stove was turned off, by averaging data obtained in the kitchen, living room, and bedroom. These whole-house measured values were then compared with model predictions. The deviations between measured and modeled concentrations for all three pollutants were averaged to yield a single deviation for each experiment. Results are shown in Figure 6.

For the three tests conducted in the absence of mechanical ventilation, the deviations are very

small. For the seven tests conducted during whole-house ventilation, the deviations are consistently below zero, indicating a small overprediction by the model. Traynor et al. attribute this to an exhaust duct in the kitchen which may have reduced the source strength slightly.

Overall, these results suggest the viability of using emission factors for gas stoves in one compartment models to predict indoor concentrations of the emitted pollutants. Agreement between measured and modeled concentrations in this one story house is generally within 10%.

Study of Borrazzo et al. (1986)

These investigators used their gas stove in an occupied two-story townhouse. The total volume of the townhouse was 240 m^3, evenly divided between first and second stories. Pollutants of interest included CO, NO, and NO_2. A diagram of the house and sampling system is shown in Figure 7. The overall objective of the study was to compare concentrations predicted using a one compartment model with those measured in the kitchen, living room, and master bedroom. Source emissions were measured using the direct technique discussed earlier, while air exchange rates were estimated using SF_6 tracer gas decay. Sink terms were evaluated by comparing pollutant decay with that of SF_6.

This study differed from that of Traynor et al. (1982b) in two respects. First, the values of S in equation 3 were determined as a function of time after turning on the stove; S was assumed to have the form of equation 4 and values for the parameters S_{ss}, S_o, and b were determined. Second, the influence of two stories in the townhouse was examined by the use of multiple tracer gases. CO was released downstairs while SF_6 was released upstairs to examine airflows between these two compartments. There were no mechanical ventilation systems used during any of these tests.

Comparisons of the one compartment model predictions with measured concentrations in the living room are shown in Figure 9. The one compartment model has been nondimensionalized to yield equations 10a and 10b. This allows the predictions from experiments with different burn times and different air exchange rates to be plotted on the same axes. In addition, Table 6 compares the peak concentrations predicted with the one compartment model, using both steady-state and transient emission factors, with measured peak concentrations in the living room. Comparisons for the kitchen and bedroom would yield similar results. Overall, this information suggests reasonable agreement between predicted and measured concentrations.

It is important to note that the use of either transient or steady-state emission factors for NO_2 would yield satisfactory results in the mass balance model. This is because emissions of NO_2 are roughly constant with time after turning on the stove, as shown in Figure 8. Emissions of NO, however, show a small increase with time during the first 20 minutes after

the stove is turned on. For CO, the effect is more dramatic; emissions decrease by a factor of 3 during the first 20 minutes. For CO and to a lesser extent for NO, these initial variations may alter the predicted concentrations resulting from short-term stove use suggesting the importance of using a transient rather than steady-state source term, at least for the cooking load used by Borrazzo et al. (1986).

Multiple tracer gas tests in the townhouse showed that internal mixing was generally much faster than whole-house air exchange rates. This implies that the one compartment model is adequate for predicting concentrations of stove-generated pollutants under these conditions.

The Influence of Uncertainties in Emission Factors on Uncertainties in Predicted Airborne Concentrations

Using the one-compartment model equations summarized above, the sensitivity of indoor pollutant concentrations to uncertainties in the model parameters S and $\frac{q'}{V}$ was examined. S depends upon EF which, in turn, varies systematically with the factors discussed earlier. However, no attempt was made to explain any of the variance in EF in terms of the factors considered above in this sensitivity analysis. The variance used is thus a maximum for the emission factor data available. Note that S is assumed to be constant in this analysis.

The data set used for sensitivity analysis is for emission factors at the maximum gas flow rate (Appendix 1). No data were available to estimate the mean and variance of the population of gas flow rates, and few stoves were tested at gas flow rates other than the maximum. For this reason, the variance in the entire population of source emission rates may have been underestimated.

Assuming that $C_o = 0$ and $C' = 0$, the solution to the one-compartment model equation is simply:

$$C = \frac{S}{aV}(1-e^{-at}) \qquad (12)$$

where $a = (\frac{q'}{V} + k)$

Since this solution and its derivatives with respect to S and q'/V increase as t gets larger, the steady-state solution has been used for the sensitivity analysis; this is a worst case. If derivatives are taken with respect to ln S and ln $\frac{q'}{V}$ the result is

$$\frac{\partial C}{\partial (ln\ S)} = -\frac{\partial C}{\partial (ln\ \frac{q'}{V})} = \frac{S}{aV} \qquad (13)$$

Since, to first order,

$$Var[C] = \frac{\partial C}{\partial (ln\ S)}^2 Var[ln\ S] + \frac{\partial C}{\partial (ln \frac{q'}{V})}^2 Var[ln \frac{q'}{V}] + \ldots \quad (14)$$

it can be seen that the relative contributions to Var [C] of ln S and ln $\frac{q'}{V}$ are proportional to their associated variances.

The results of the analysis are shown in Table 7. As expected, the uncertainty in the emission factor for CO is responsible for a larger fraction of the variance in C than the uncertainty in $\frac{q'}{V}$. Estimates of the mean and variance of ln $\frac{q'}{V}$ have been calculated from air exchange rates measured for a sample of 260 homes (Grot and Clark, 1979). This can also be thought of as a worst case analysis for the factor $\frac{q'}{V}$, since for any given home the uncertainty in $\frac{q'}{V}$ will be less than that for the entire population. For NO and NO_2, the uncertainty in $\frac{q'}{V}$ is responsible for a larger fraction of the variance in C than the uncertainties in the emission factors, which are relatively smaller than that for CO.

IV. IDENTIFICATION OF CRITICAL GAPS AND DESIGN OF FUTURE EMISSION FACTOR EXPERIMENTS

The literature summarized in the previous sections indicates that we have limited knowledge of some factors affecting CO, NO, and NO_2 emissions, and virtually no information on the effects of other factors. This section uses the results of earlier discussions to identify critical gaps in our understanding of emission factors and to provide guidance in designing future experiments. Each of several factors influencing emissions will now be discussed.

Type of Combustion

Throughout the report, this factor has been treated as a binary variable, with levels defined as poorly adjusted combustion and well adjusted combustion. The statistical tests conducted earlier have shown a significant difference in emissions between the two levels.

Obtaining information on the distribution of this factor for stoves in occupied houses is beyond the scope of this study. If most stoves currently in use are characterized by well adjusted combustion, or most are characterized by poorly adjusted combustion, then accounting for this factor is unnecessary. If, however, there is a wide distribution of primary aeration leading to a wide distribution of combustion characteristics, then this factor may need to be accounted for. Establishing the number of levels at which to test must then be established; use of only two levels, as with currently available data, may or may not be sufficient.

Stove Design

Earlier statistical tests attempted to explain the variance in emission factors on the basis of different stove designs. The results of these tests showed that stove type was significant in influencing emissions. However, no attempt was made in this study to identify aspects of stove design which may have been responsible for the differences in emission factors. Himmel and DeWerth (1974) identify some of these aspects as burner port design, port area, port loading, position of lip on the port, primary aeration (discussed in the previous section), and secondary aeration.

Future tests may need to address the issue of parameterization of stoves to estimate emission factors. Surveys of stoves currently in use may be needed to establish the distribution of parameters associated with these stoves.

Gas Flow Rate

Very limited data were available for assessing the influence of gas flow rate on emissions. One study reported emission factors for a large number of gas flow rates for a single stove, while three additional studies reported emission factors at a few gas flow rates on a small number of stoves. The data, plotted in Figures 2a–d, suggest significant variations in emission factor for CO and NO_2 with smaller variations for NO and NO_x with respect to gas flow rate.

Establishing quantitative relations between emissions and gas flow rate requires additional testing. It is of particular importance to establish the number of levels at which this factor should be tested: for CO and NO_2, emissions measured at several gas flow rates may be needed. If quantitative models are to be established for stoves currently in use, tests of emissions as a function of gas flow rate will be needed for a variety of different stove types. In addition, surveys of gas flow rates used in homes will be needed if results of the emissions tests suggest that gas flow rate significantly influences emissions.

Sampling Method and Burner Position

Both of these factors were discussed earlier in this report. Available information suggests no significant differences in emissions measured by the indirect and direct methods, implying that data obtained from both techniques can be used without accounting for the sampling method.

Emissions from the front and rear burners also show little difference. As cited above, Himmel and DeWerth (1974) report a small difference in NO_2 emissions on the front and rear burners, consistent with the results of Table 3b. However, this factor is probably much less important than the other factors influencing emissions.

Cooking Load

Very little information was available on the influence of cooking load on emissions. Himmel and DeWerth (1974) examined emissions for several physical properties of cookpots, including specific heat, thermal conductivity, density, emissivity, and heat capacity. Their results, obtained on one stove, showed no significant effect of these properties on emissions of CO, NO, and NO_2.

There is insufficient information to establish whether cooking load significantly affects emissions for most stoves in use. To establish the importance of this factor, additional emissions testing would be needed, as well as surveys of cooking loads commonly used. The number of levels for this factor would need to be determined.

Humidity and Temperature

Moschandreas et al. (1985) reported decreasing emissions of NO and NO_2 with increasing relative humidity in their chamber. The influence of humidity on CO emissions is unknown. Additional information on humidity as a factor in influencing emissions, as well as distributions of indoor humidity levels, would be needed if the importance of humidity is to be established.

There is little information on the influence of temperature on emissions of CO, NO, and NO_2. However, the small range of temperatures found indoors make investigation of temperature as a factor somewhat less important.

Summary of Factors to be Investigated in Future Experiments

The information presented in this section suggests that type of combustion, stove design, and gas flow rate are key factors influencing emissions of CO, NO, and NO_2. Sampling method and burner position are of relatively minor importance. There is little information on the effects of cooking load, humidity, temperature, and other possible factors. Better information on the influence of these factors on emissions is needed.

Even more important, use of emission factors in indoor air quality models will require information on the population of stoves, and the way in which stoves are currently used in residences. Surveys in occupied residences are needed to obtain this information. Designing such surveys is outside of the scope of this study, but merits high priority in terms of indoor air quality research.

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TABLES AND FIGURES

Table 1. References providing emission factor data for the various statistical tests.

	Number of Stoves	Number of Burners	Number of Observations	Number of Tests	Method of Testing	Pollutants Reported			
Himmel & DeWerth (1974)	18	70	140	140	Direct	CO	NO	NO_2	-[a]
Cote et al. (1974)	2	2	2	NA	Indirect	CO	NO	NO_2	NO_x
Massachusetts Institute of Technology (1976)	1	1	1	NA	Direct	CO	NO	NO_2	NO_x
Traynor et al. (1982a)	1	2	1	5	Indirect	CO	-[b]	-[b]	NO_x
Fortmann et al. (1984)	2[c]	4	4	11	Direct	CO	NO	NO_2	-
Moschandreas et al. (1985)	3[d]	12	36	146	Direct	CO	NO	NO_2	NO_x
	3[d]	3	6	72	Indirect	CO	NO	NO_2	NO_x
Borrazzo et al. (1986)	1[c]	1	1	16	Direct	CO	NO	NO_2	NO_x
	27	91	191						

[a]Himmel & DeWerth (1974) reported NO_x values, but their method of computing NO_x from NO and NO_2 data was inconsistent with the method used by other investigators. Thus their NO_x values have not been included.

[b]Traynor et al. (1982a) did not report NO and NO_2 separately. The values reported in their reference assumed a volumetric ratio of 1:1 for NO:NO_2, and hence only NO_x data are included in the statistical tests run as part of this project.

[c]One of the stoves tested by Fortmann et al. (1984) was also tested by Borrazzo et al. (1986).

[d]One burner on each of three stoves tested using the indirect method was also tested using the direct method.

Table 2a. Summary of CO emission factor data (μg/kJ).

	Number of Stoves	Number of Burners	Number of Observations	Arith. Mean	Arith. Std. Dev.	Geom. Mean	Geom. Std. Dev.	Normal Corr. Coef.	Lognormal Corr. Coef.
All	27	91	193	124.0	149.0	61.7	3.58	0.860	0.990
Rear	21	41	88	111.0	154.0	52.0	3.65	0.808	0.992
Front	23	45	100	137.0	147.0	71.8	3.52	0.895	0.986
Indirect	6	7	10	191.0	156.0	130.9	2.59	0.920	0.935
Direct	24	87	183	120.0	148.0	59.2	3.60	0.851	0.990
Front	23	45	93	130.0	144.0	67.6	3.52	0.885	0.987
Rear	21	41	88	111.0	154.0	52.0	3.65	0.808	0.992
Poorly Adjusted	21	82	86	217.0	175.0	154.9	2.48	0.922	0.977
Rear	21	41	41	199.0	188.0	137.1	2.49	0.867	0.985
Front	21	41	44	237.0	163.0	174.2	2.49	0.956	0.953
Indirect	3	3	3	394.7	24.9	394.2	1.07	0.977	0.973
Direct	21	82	83	211.0	174.0	149.6	2.48	0.912	0.979
Front	21	41	41	225.0	163.0	164.1	2.51	0.947	0.960
Rear	21	41	41	199.0	188.0	137.1	2.49	0.867	0.985
Well Adjusted	27	91	107	48.5	53.8	29.4	2.77	0.857	0.994
Rear	21	41	47	34.5	37.5	22.3	2.55	0.847	0.992
Front	23	45	56	58.0	60.9	35.6	2.81	0.870	0.993
Indirect	6	7	7	103.3	82.5	81.7	2.02	0.863	0.914
Direct	24	87	100	44.7	49.6	27.4	2.72	0.850	0.992
Front	23	45	52	54.5	57.5	33.6	2.81	0.862	0.990
Rear	21	41	47	34.5	37.5	22.3	2.55	0.847	0.992

Table 2b. Summary of NO emission factor data (μg/kJ).

	Number of Stoves	Number of Burners	Number of Observations	Arith. Mean	Arith. Std. Dev.	Geom. Mean	Geom. Std. Dev.	Normal Corr. Coef.	Lognormal Corr. Coef.
All	26	89	192	17.5	4.9	16.8	1.37	0.995	0.960
Rear	21	41	88	17.9	4.8	17.1	1.37	0.994	0.946
Front	23	45	100	17.0	4.7	16.2	1.36	0.992	0.961
Indirect	5	5	9	16.6	6.6	15.6	1.45	0.941	0.985
Direct	24	87	183	17.6	4.8	16.9	1.37	0.994	0.954
Front	23	45	93	17.2	4.7	16.5	1.37	0.991	0.955
Rear	21	41	88	17.9	4.8	17.1	1.37	0.994	0.946
Poorly Adjusted	21	82	86	15.6	4.9	14.7	1.43	0.994	0.963
Rear	21	41	41	15.8	4.4	15.0	1.41	0.986	0.928
Front	21	41	44	15.2	5.2	14.3	1.45	0.986	0.971
Indirect	3	3	3	10.9	2.0	10.8	1.21	1.000	1.000
Direct	21	82	83	15.8	4.8	14.9	1.43	0.993	0.957
Front	21	41	41	15.6	5.2	14.6	1.46	0.984	0.962
Rear	21	41	41	15.8	4.4	15.0	1.41	0.986	0.928
Well Adjusted	26	89	106	19.2	4.3	18.7	1.26	0.988	0.980
Rear	21	41	47	19.7	4.4	19.2	1.28	0.984	0.956
Front	23	45	56	18.3	3.7	17.9	1.23	0.985	0.986
Indirect	5	5	6	19.5	6.2	18.7	1.33	0.893	0.926
Direct	24	87	100	19.1	4.2	18.7	1.26	0.989	0.976
Front	23	45	52	18.5	3.8	18.1	1.24	0.988	0.985
Rear	21	41	47	19.7	4.4	19.2	1.28	0.984	0.956

Table 2c. Summary of NO_2 emission factor data (μg/kJ).

	Number of Stoves	Number of Burners	Number of Observations	Arith. Mean	Arith. Std. Dev.	Geom. Mean	Geom. Std. Dev.	Normal Corr. Coef.	Lognormal Corr. Coef.
All	26	89	192	11.2	4.5	10.5	1.43	0.922	0.983
Rear	21	41	88	10.5	4.5	9.8	1.42	0.876	0.967
Front	23	45	100	11.7	4.5	11.0	1.42	0.943	0.990
Indirect	5	5	9	12.9	4.1	12.3	1.39	0.987	0.989
Direct	24	87	183	11.1	4.6	10.4	1.43	0.917	0.982
Front	23	45	93	11.7	4.5	11.0	1.42	0.939	0.989
Rear	21	41	88	10.5	4.5	9.8	1.42	0.876	0.967
Poorly Adjusted	21	82	86	13.8	5.1	13.0	1.40	0.941	0.992
Rear	21	41	41	13.1	5.4	12.2	1.44	0.912	0.979
Front	21	41	44	14.6	4.8	13.9	1.35	0.947	0.991
Indirect	3	3	3	16.1	3.4	15.8	1.25	0.997	0.991
Direct	21	82	83	13.7	5.1	12.9	1.40	0.937	0.991
Front	21	41	41	14.5	4.9	13.8	1.36	0.942	0.989
Rear	21	41	41	13.1	5.4	12.2	1.44	0.912	0.979
Well Adjusted	26	89	106	9.2	2.6	8.8	1.30	0.942	0.980
Rear	21	41	47	8.3	1.6	8.1	1.21	0.984	0.992
Front	23	45	56	9.5	2.7	9.2	1.31	0.962	0.983
Indirect	5	5	6	11.3	3.7	10.9	1.37	0.971	0.992
Direct	24	87	100	9.0	2.5	8.7	1.29	0.944	0.980
Front	23	45	52	9.5	2.8	9.2	1.32	0.960	0.982
Rear	21	41	47	8.3	1.6	8.1	1.21	0.984	0.992

Table 2d. Summary of NO_x emission factor data (μg/kJ).

	Number of Stoves	Number of Burners	Number of Observations	Arith. Mean	Arith. Std. Dev.	Geom. Mean	Geom. Std. Dev.	Normal Corr. Coef.	Lognormal Corr. Coef.
All	8	18	48	37.4	5.8	37.0	1.14	0.823	0.886
Rear	3	6	18	36.7	2.4	36.7	1.07	0.969	0.965
Front	5	10	26	36.1	2.7	35.9	1.08	0.946	0.933
Indirect	6	7	10	37.3	11.0	36.1	1.28	0.848	0.897
Direct	5	14	38	37.4	3.6	37.3	1.09	0.808	0.861
Front	5	10	19	37.1	1.6	37.1	1.05	0.969	0.965
Rear	3	6	18	36.7	2.4	36.7	1.07	0.969	0.965
Poorly Adjusted	3	12	15	37.1	2.8	37.0	1.08	0.914	0.897
Rear	3	6	6	38.0	1.6	38.0	1.04	0.985	0.984
Front	3	6	9	36.4	3.4	36.3	1.10	0.923	0.911
Indirect	3	3	3	32.6	3.0	32.5	1.10	0.997	0.998
Direct	3	12	12	38.2	1.3	38.2	1.03	0.981	0.979
Front	3	6	6	38.4	1.0	38.4	1.03	0.988	0.989
Rear	3	6	6	38.0	1.6	38.0	1.04	0.985	0.984
Well Adjusted	8	18	33	37.5	6.8	37.1	1.16	0.817	0.877
Rear	3	6	12	36.1	2.6	36.0	1.07	0.958	0.956
Front	5	10	17	35.8	2.4	35.8	1.07	0.931	0.917
Indirect	6	7	7	39.3	12.7	37.8	1.33	0.895	0.934
Direct	5	14	26	37.1	4.3	36.9	1.11	0.787	0.841
Front	5	10	13	36.5	1.6	36.5	1.04	0.960	0.957
Rear	3	6	12	36.1	2.6	36.0	1.07	0.958	0.956

Table 3a. Results of one-way analysis of variance for $\log_{10}$ EF as a function of Type of Combustion factor.

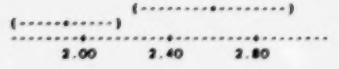
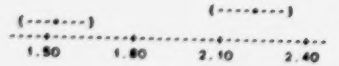
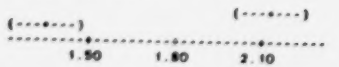
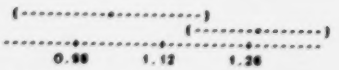
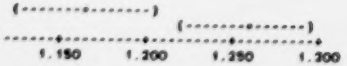
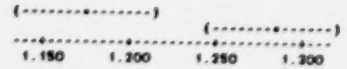
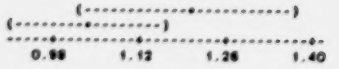
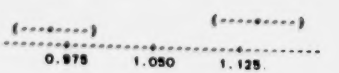
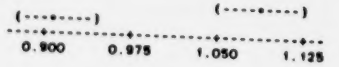
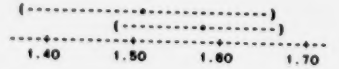
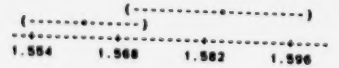
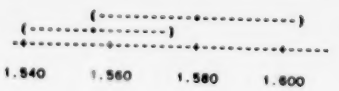
	r^2	Parameter Level	Number of Obs.	$\log_{10}$ EF mean[a]	$\log_{10}$ EF s[b]	Level of Significant Difference	95% Confidence Interval[c]
CO:							
All Indirect	0.636	Poorly Adjusted	3	2.60	0.028	0.95[d]	
		Well Adjusted	7	1.91	0.306		
All Direct Front	0.396	Poorly Adjusted	41	2.22	0.399	0.95	
		Well Adjusted	52	1.53	0.448		
All Direct Rear	0.496	Poorly Adjusted	41	2.14	0.396	0.95	
		Well Adjusted	47	1.35	0.406		
NO:							
All Indirect	0.560	Poorly Adjusted	3	1.03	0.084	0.90[e]	
		Well Adjusted	6	1.27	0.124		
All Direct Front	0.117	Poorly Adjusted	41	1.17	0.164	0.95	
		Well Adjusted	52	1.26	0.092		
All Direct Rear	0.148	Poorly Adjusted	41	1.18	0.149	0.95	
		Well Adjusted	47	1.28	0.107		
NO_2:							
All Indirect	0.321	Poorly Adjusted	3	1.20	0.096	-[f]	
		Well Adjusted	6	1.04	0.137		
All Direct Front	0.333	Poorly Adjusted	41	1.14	0.133	0.95	
		Well Adjusted	52	0.96	0.119		
All Direct Rear	0.341	Poorly Adjusted	41	1.09	0.158	0.95	
		Well Adjusted	47	0.91	0.082		
NO_x:							
All Indirect	0.088	Poorly Adjusted	3	1.51	0.040	-	
		Well Adjusted	7	1.58	0.124		
All Direct Front	0.292	Poorly Adjusted	6	1.58	0.011	0.90	
		Well Adjusted	13	1.56	0.019		
All Direct Rear	0.145	Poorly Adjusted	6	1.58	0.019	-	
		Well Adjusted	12	1.56	0.031		

Table 3b. Results of one-way analysis of variance for $\log_{10}$ EF as a function of Burner Position factor.

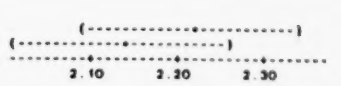
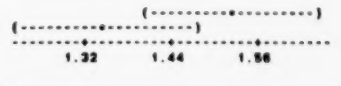
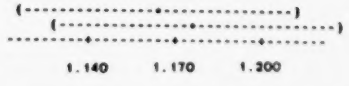
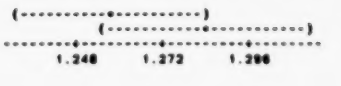
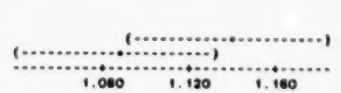
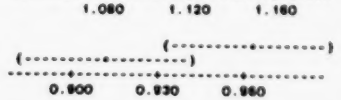
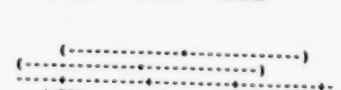
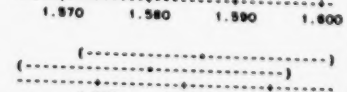
	r^2	Parameter Level	Number of Obs.	$\log_{10}$ EF mean[a]	$\log_{10}$ EF s[b]	Level of Significant Difference	95% Confidence Interval[c]
CO:							
Direct, Poorly Adjusted	0.010	Front	41	2.22	0.399	-[f]	
		Rear	41	2.14	0.396		
Direct, Well Adjusted	0.042	Front	52	1.53	0.448	-	
		Rear	47	1.35	0.406		
NO:							
Direct, Poorly Adjusted	0.002	Front	41	1.17	0.164	-	
		Rear	41	1.18	0.149		
Direct, Well Adjusted	0.017	Front	52	1.26	0.092	-	
		Rear	47	1.28	0.107		
NO_2:							
Direct, Poorly Adjusted	0.032	Front	41	1.14	0.133	0.90[e]	
		Rear	41	1.09	0.158		
Direct, Well Adjusted	0.060	Front	52	0.96	0.119	0.90	
		Rear	47	0.91	0.082		
NO_x:							
Direct, Poorly Adjusted	0.029	Front	6	1.58	0.011	-	
		Rear	6	1.58	0.019		
Direct, Well Adjusted	0.014	Front	13	1.56	0.019	-	
		Rear	12	1.56	0.031		

Table 3b. Results of one-way analysis of variance for $\log_{10}$ EF as a function of Burner Position factor.

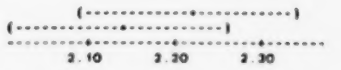
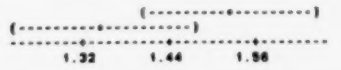
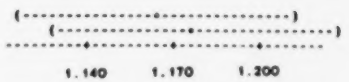
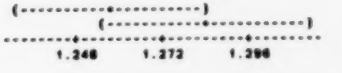
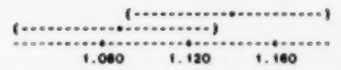
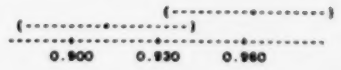
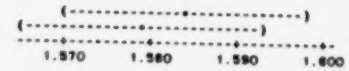
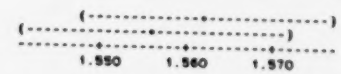
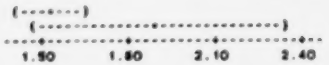
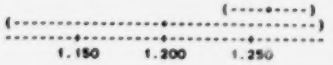
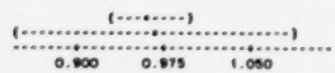
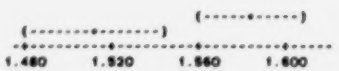
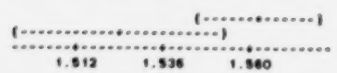
	r^2	Parameter Level	Number of Obs.	$\log_{10}$ EF mean[a]	$\log_{10}$ EF s[b]	Level of Significant Difference[f]	95% Confidence Interval[c]
CO:							
Direct, Poorly Adjusted	0.010	Front	41	2.22	0.399	-	
		Rear	41	2.14	0.396		
Direct, Well Adjusted	0.042	Front	52	1.53	0.448	-	
		Rear	47	1.35	0.406		
NO:							
Direct, Poorly Adjusted	0.002	Front	41	1.17	0.164	-	
		Rear	41	1.18	0.149		
Direct, Well Adjusted	0.017	Front	52	1.26	0.092	-	
		Rear	47	1.28	0.107		
NO_2:							
Direct, Poorly Adjusted	0.032	Front	41	1.14	0.133	0.90[e]	
		Rear	41	1.09	0.158		
Direct, Well Adjusted	0.060	Front	52	0.96	0.119	0.90	
		Rear	47	0.91	0.082		
NO_x:							
Direct, Poorly Adjusted	0.029	Front	6	1.58	0.011	-	
		Rear	6	1.58	0.019		
Direct, Well Adjusted	0.014	Front	13	1.56	0.019	-	
		Rear	12	1.56	0.031		

Table 3c. Results of one-way analysis of variance for $\log_{10}$ EF as a function of Method of Sampling factor.

	r^2	Parameter Level	Number of Obs.	$\log_{10}$ EF mean[a]	$\log_{10}$ EF s[b]	Level of Significant Difference	95% Confidence Interval[c]
CO:							
Front, Poorly Adjusted	0.060	Direct	41	2.22	0.399	-[f]	
		Indirect	3	2.60	0.028		
Front, Well Adjusted	0.047	Direct	52	1.53	0.448	-	
		Indirect	4	1.90	0.338		
NO:							
Front, Poorly Adjusted	0.043	Direct	41	1.17	0.164	-	
		Indirect	3	1.03	0.084		
Front, Well Adjusted	0.026	Direct	52	1.26	0.092	-	
		Indirect	4	1.20	0.035		
NO_2:							
Front, Poorly Adjusted	0.014	Direct	41	1.14	0.133	-	
		Indirect	3	1.20	0.096		
Front, Well Adjusted	0.000	Direct	52	0.96	0.119	-	
		Indirect	4	0.97	0.096		
NO_x:							
Front, Poorly Adjusted	0.733	Direct	6	1.58	0.011	0.95[d]	
		Indirect	3	1.51	0.040		
Front, Well Adjusted	0.290	Direct	13	1.56	0.019	0.90[e]	
		Indirect	4	1.52	0.047		

Footnotes to Tables 3a, 3b, and 3c.

[a]arithmetic mean

[b]s = standard deviation

[c]based on weighted standard deviation, $s_w^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1 + n_2 - 2}$ where n_i = number of observations at level i of the factor being tested.

[d]significant at the 95% level

[e]significant at the 90% level

[f]not significant at the 90% level

Table 4a. Results of multivariate regression for $\log_{10}$ EF for CO.

Factors Included	Factor Tested	K[b]	r_K^2[c]	Q[d]	r_Q^2[e]	$F_{Q-K,n-Q}$[f]	Significance[g]
Burner Position Method of Sampling Type of Combustion Interactions[a] Stove Differences	-	32	0.653	-	-	-	-
Burner Position Method of Sampling Type of Combustion Stove Differences	Interactions	30	0.652	32	0.653	0.183	-
Burner Position Type of Combustion Stove Differences	Method of Sampling	29	0.645	30	0.652	2.574	-
Type of Combustion Stove Differences	Burner Position	28	0.634	29	0.645	3.951	0.95
Type of Combustion	Stove Differences	2	0.422	28	0.634	2.376	0.95
Stove Differences	Type of Combustion	27	0.158	28	0.634	104.0	0.95

Table 4b. Results of multivariate regression for $\log_{10}$ EF for NO.

Factors Included	Factor Tested	K[b]	r_K^2 [c]	Q[d]	r_Q^2 [e]	$F_{Q-K,n-Q}$ [f]	Significance[g]
Burner Position Method of Sampling Type of Combustion Interactions[a] Stove Differences	-	31	0.430	-	-	-	-
Burner Position Method of Sampling Type of Combustion Stove Differences	Interactions	29	0.427	31	0.430	0.254	-
Burner Position Type of Combustion Stove Differences	Method of Sampling	28	0.419	29	0.427	1.349	-
Type of Combustion Stove Differences	Burner Position	27	0.415	28	0.419	0.664	-
Type of Combustion	Stove Differences	2	0.138	27	0.415	1.221	-
Stove Differences	Type of Combustion	26	0.278	27	0.415	18.92	0.95

Table 4c. Results of multivariate regression for $\log_{10}$ EF for NO_2.

Factors Included	Factor Tested	K[b]	r_K^2[c]	Q[d]	r_Q^2[e]	$F_{Q-K,n-Q}$[f]	Significance[g]
Burner Position Method of Sampling Type of Combustion Interactions[a] Stove Differences	-	31	0.600	-	-	-	-
Burner Position Method of Sampling Type of Combustion Stove Differences	Interactions	29	0.599	31	0.600	0.151	-
Burner Position Type of Combustion Stove Differences	Method of Sampling	28	0.599	29	0.599	0.000	-
Type of Combustion Stove Differences	Burner Position	27	0.576	28	0.599	6.912	0.95
Type of Combustion	Stove Differences	2	0.298	27	0.576	2.400	0.95
Stove Differences	Type of Combustion	26	0.219	27	0.576	70.08	0.95

Table 4d. Results of multivariate regression for $\log_{10}$ EF for NO_x.

Factors Included	Factor Tested	K[b]	r_K^2[c]	Q[d]	r_Q^2[e]	$F_{Q-K,n-Q}$[f]	Significance[g]
Burner Position Method of Sampling Type of Combustion Interactions[a] Stove Differences	-	13	0.883	-	-	-	-
Burner Position Method of Sampling Type of Combustion Stove Differences	Interactions	11	0.868	13	0.883	2.086	-
Method of Sampling Type of Combustion Stove Differences	Burner Position	10	0.867	11	0.868	0.260	-
Method of Sampling Stove Differences	Type of Combustion	9	0.852	10	0.867	3.946	0.90
Method of Sampling	Different Stoves	2	0.009	9	0.852	14.75	0.95
Different Stoves	Method of Sampling	8	0.778	9	0.852	17.16	0.95

Footnotes to Tables 4a,.4b, 4c, and 4d.

[a]Two-way interactions:

Burner Position x Method of Sampling

Burner Position x Type of Combustion

Method of Sampling x Type of Combustion

[b]Number of Factors Included + 1.

Stove Differences includes (M-1) binary factors for the M stoves. M= 27 for CO, 26 for NO and NO_2, and 8 for NO_x. One stove factor was confounded by other factors when interactions were included.

[c]Coefficient of determination for regression with K factors.

[d]Numbers of Factors Included + Number of Factors Tested + 1.

[e]Coefficient of determination for regression with Q-factors.

[f] $$F_{Q-K,n-Q} = \frac{r_Q^2 - r_K^2}{1-r_Q^2} \times \frac{n-Q}{Q-K}$$

[g] - not significant at 90% confidence level.
0.90 significant at the 90% confidence level.
0.95 significant at the 95% confidence level.

Table 5. Summary of investigations examining the effect of gas flow rate on emission factors.

	Number of Stoves	Number of Burners	Number of Observations	Number of Tests	Method of Testing	Pollutants Reported			
Himmel & DeWerth (1974)	1	1	4	NA	D[a]	CO	NO	NO_2	-
Fortmann et al. (1984)	1	1	11	11	D	CO	NO	NO_2	-
Moschandreas et al. (1985)	1	1	4	16	C	CO	NO	NO_2	NO_x
Borrazzo et al. (1986)	1	1	71	71	D	CO	NO	NO_2	NO_x

[a]Poorly-adjusted combustion conditions.

Table 6. Comparison of measured and predicted peak concentrations in the living room. Values given are means ± standard deviations (Borrazzo et al., 1986).

	t_b = 1.0 hr[a] Concentrations (ppm)			t_b = 1.5 hr[b] Concentrations (ppm)		
	Measured	Predicted using S(t)	Predicted Using S_{ss}	Measured	Predicted using S(t)	Predicted using S_{ss}
CO	6.1 ± 1.3	4.6 ± 0.70	3.8 ± 0.66	5.8 ± 0.36	6.1 ± 0.11	5.4 ± 0.10
NO	0.44 ± 0.050	0.53 ± 0.042	0.56 ± 0.043	0.69 ± 0.035	0.73 ± 0.037	0.76 ± 0.037
NO_2	0.090 ± 0.006	0.087 ± 0.005[c,d]	0.087 ± 0.005[d]	0.14 ± 0.018	0.22 ± 0.008[c]	0.22 ± 0.008
	0.22 ± 0.008	0.20 ± 0.012[e]	0.20 ± 0.012[e]			

[a] Five experiments

[b] Three experiments

[c] As seen in Figure 8, the NO_2 emissions are constant with time. Predictions using S(t) yield the same values as those using S_{ss}.

[d] September 27, 28, 1984

[e] October 1, 3, 5, 1984

Table 7. Variance in C resulting from uncertainties in log S and log $\frac{q'}{V}$ at maximum I_{gas}.

Factor x	Expected Value $E[x]$	Variance $Var[x]$	Maximum Direct Sensitivity $\left(\frac{\partial C}{\partial x}\right)_{max}$	Approximate Contribution to variance of C $\left(\frac{\partial C}{\partial x}\right)^2 Var[x]$
log S	CO: 4.0[a]	0.31[b]	270[c]	23,000
	NO: 3.4	0.02	67	90
	NO_2: 3.2	0.02	43	37
log $\frac{q'}{V}$	-0.065[d]	0.11[d]	270	8,000
			67	490
			43	200

[a] $E[\log S] = E[\log EF] + \log I_{gas}$

[b] $Var[\log S] = Var[\log EF]$

[c] Assumed $V = 100 m^3$, $k = 0 hr^{-1}$ for CO and NO, $k = 1 hr^{-1}$ for NO_2

[d] Grot and Clark (1979)

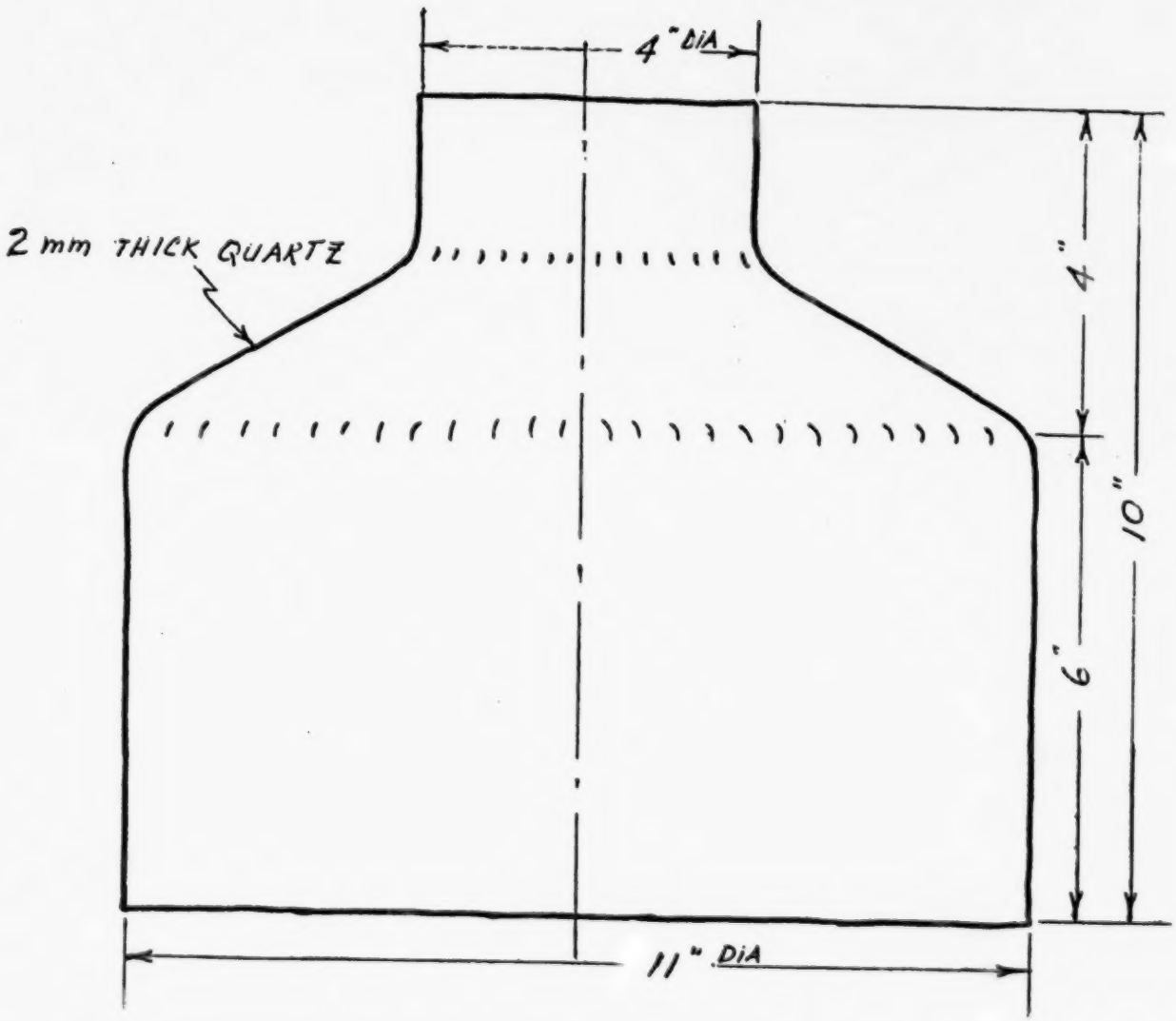


Figure 1a. Diagram of quartz hood used for sampling emissions from burners of kitchen stoves (Himmel and DeWerth, 1974).

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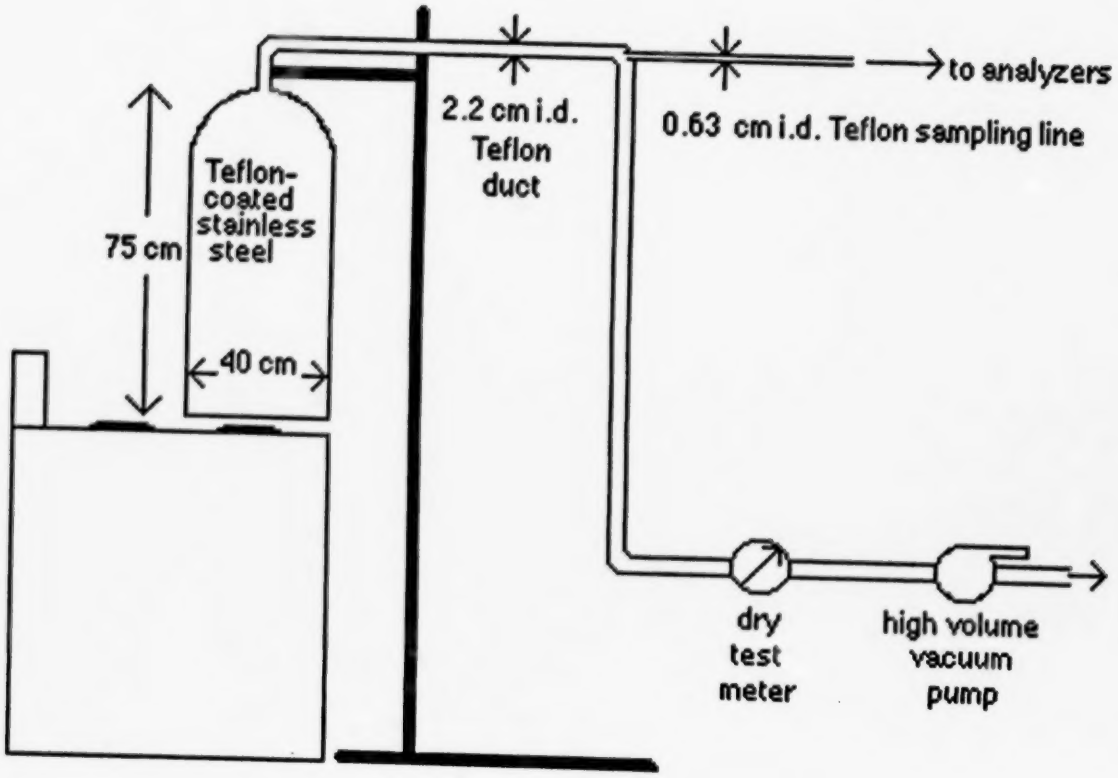

Figure 1b. Diagram of Teflon-coated stainless steel hood used for sampling emissions from burners of kitchen stoves (Borrazzo et al., 1986).

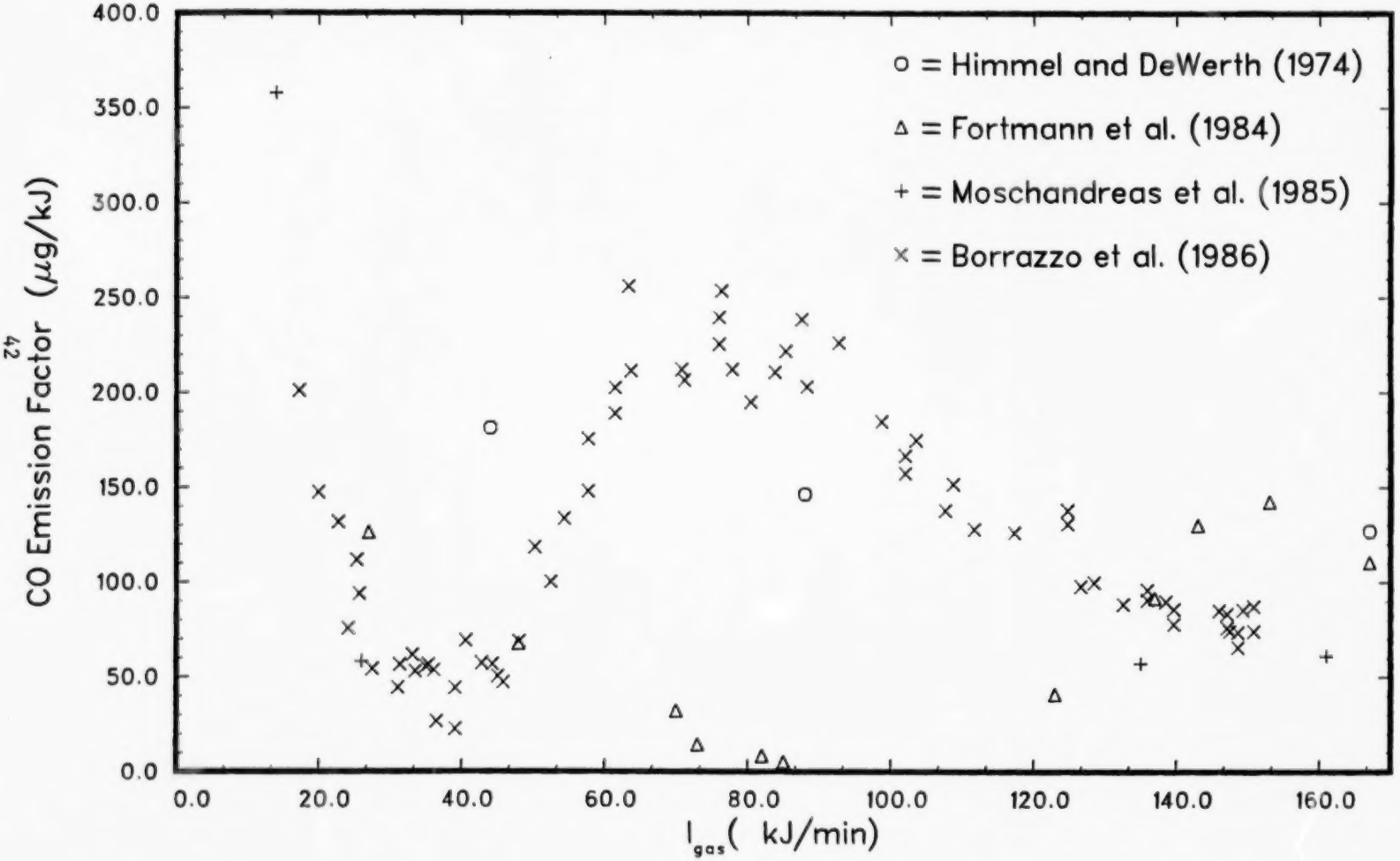

Figure 2a. Emission factors for CO as a function of gas flow rate.

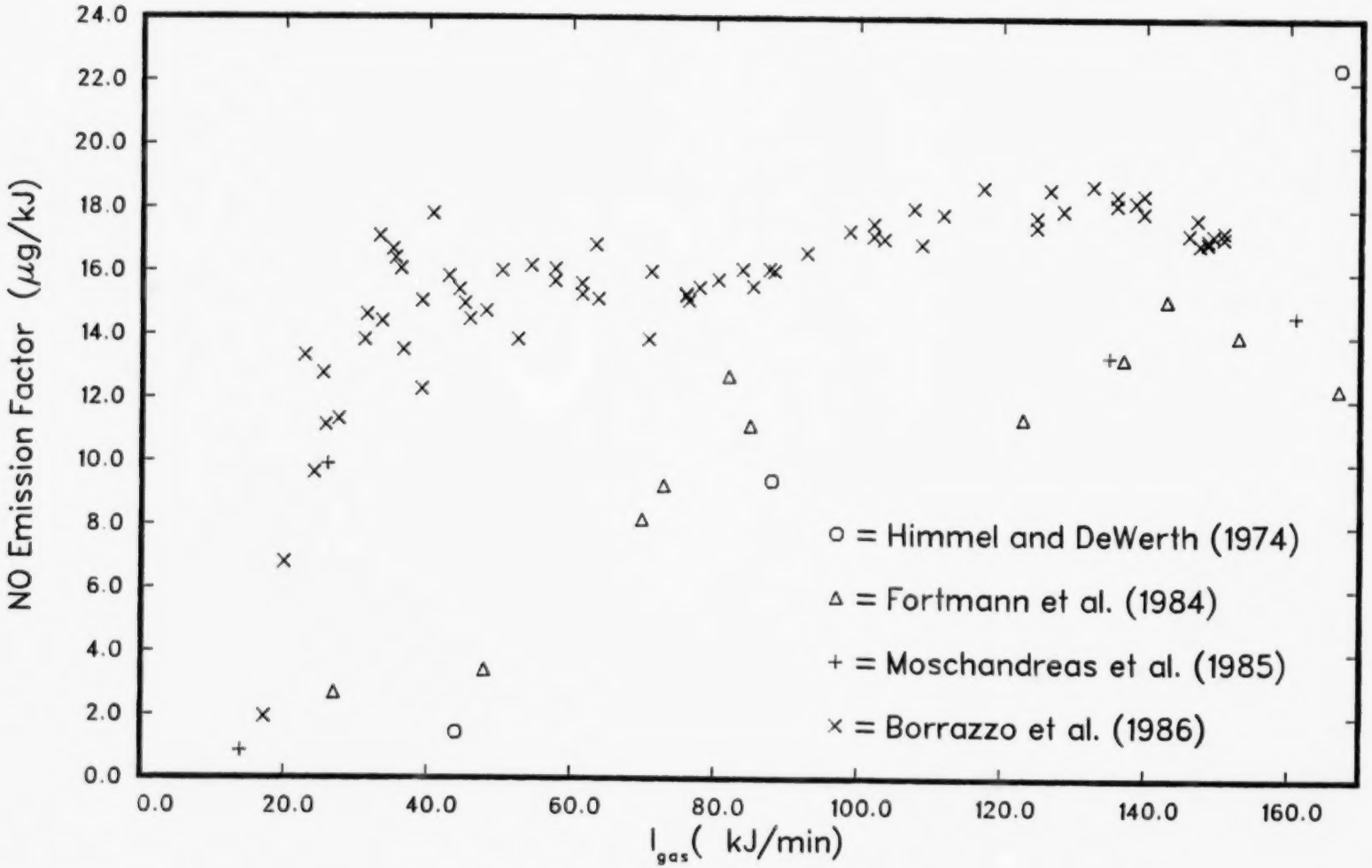

Figure 2b. Emission factors for NO as a function of gas flow rate.

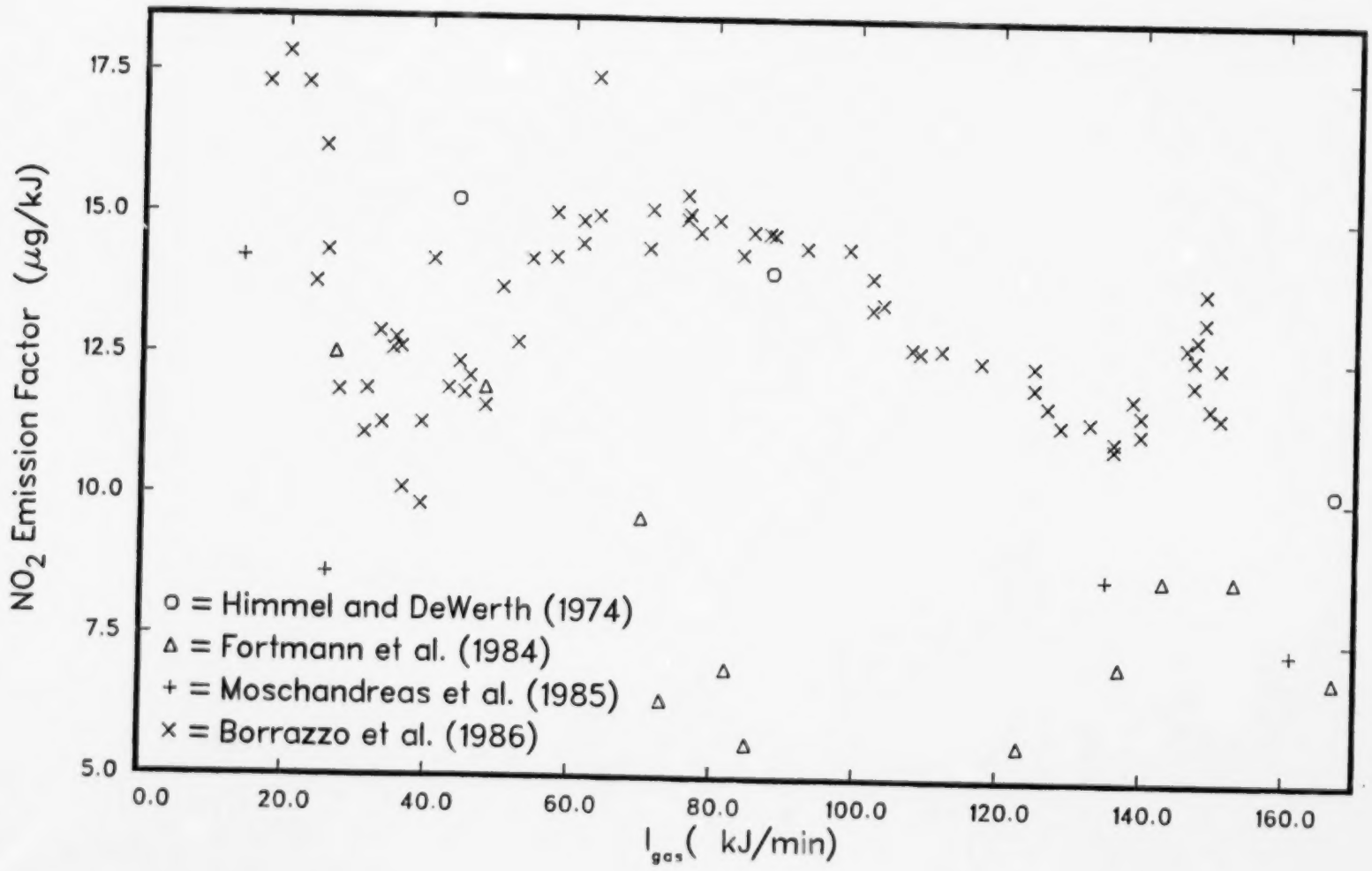

Figure 2c. Emission factors for NO_2 as a function of gas flow rate.

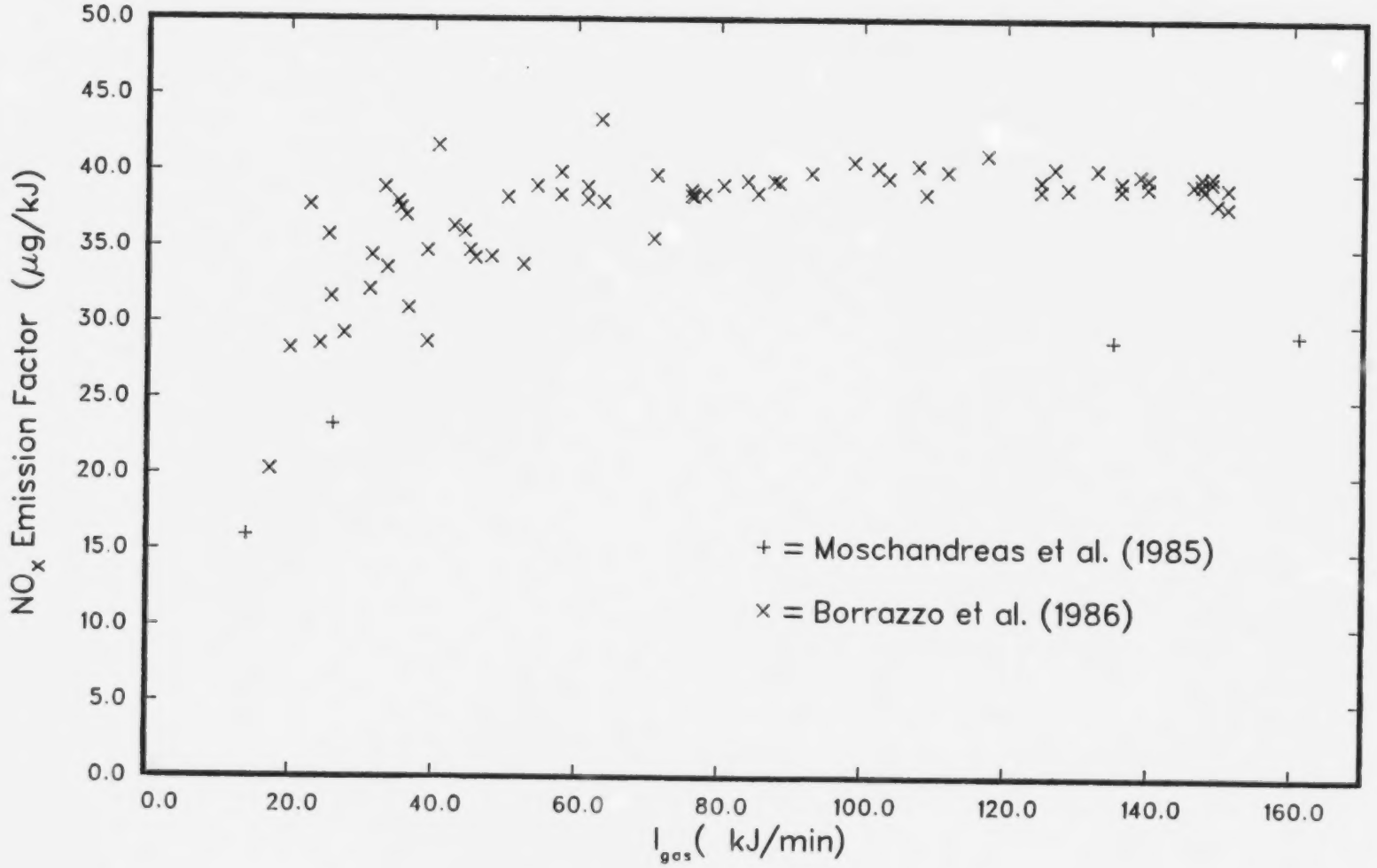

Figure 2d. Emission factors for NO_x as a function of gas flow rate.

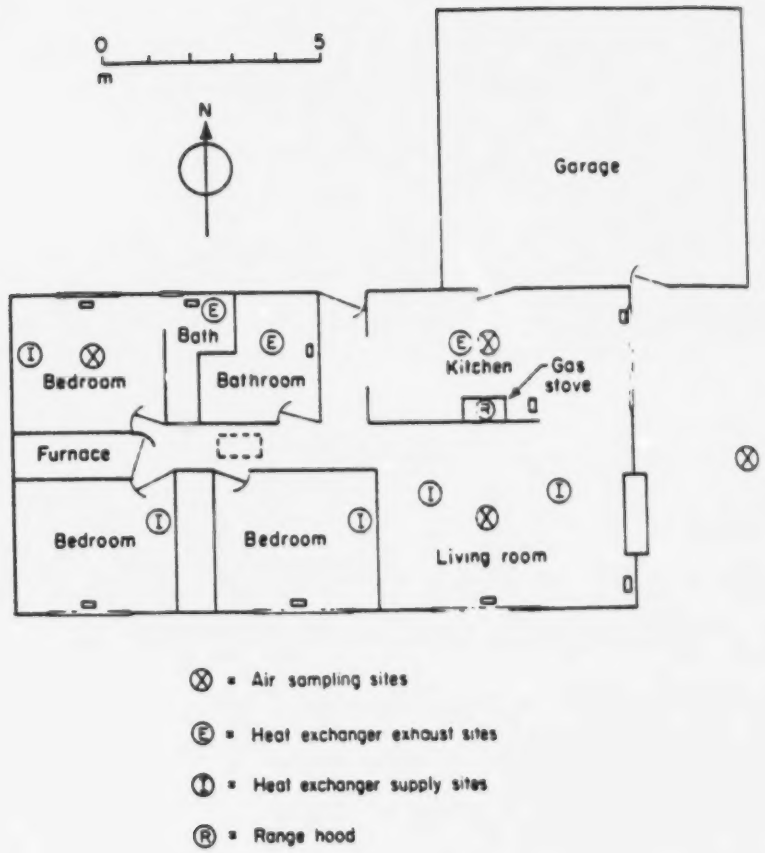

Figure 3. Floor plan of the experimental research house of Traynor et al. (1982b)

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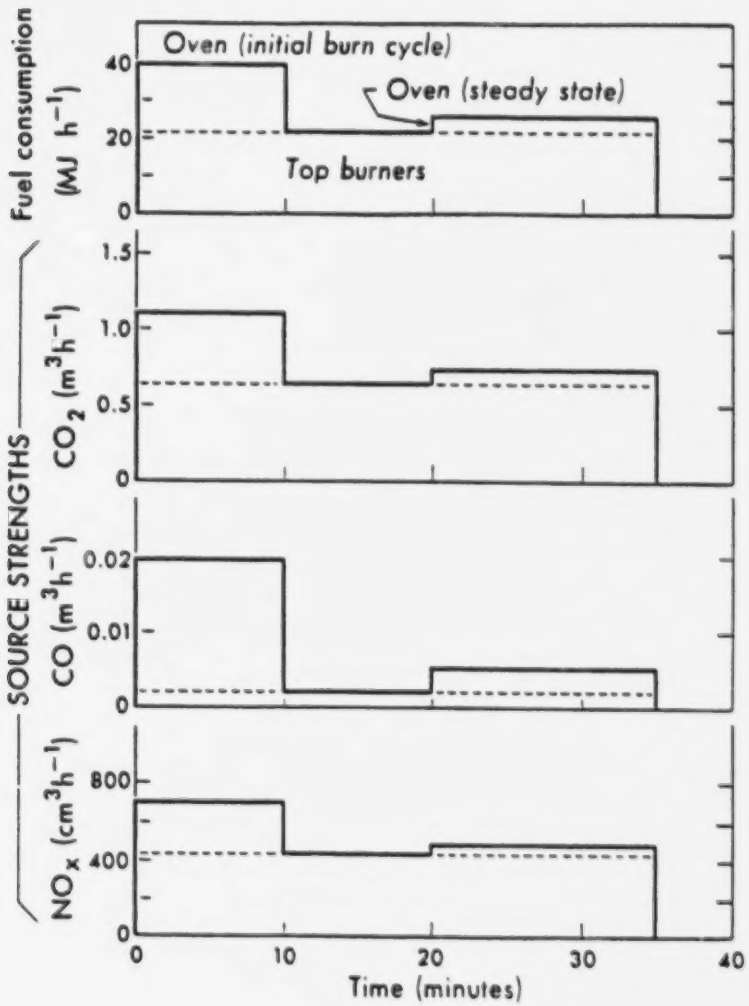

Figure 4. Fuel consumption and pollutant source strength profiles for the gas stove operated under laboratory conditions. This stove was later used in the experimental research house of Figure 3 by Traynor et al. (1982b)

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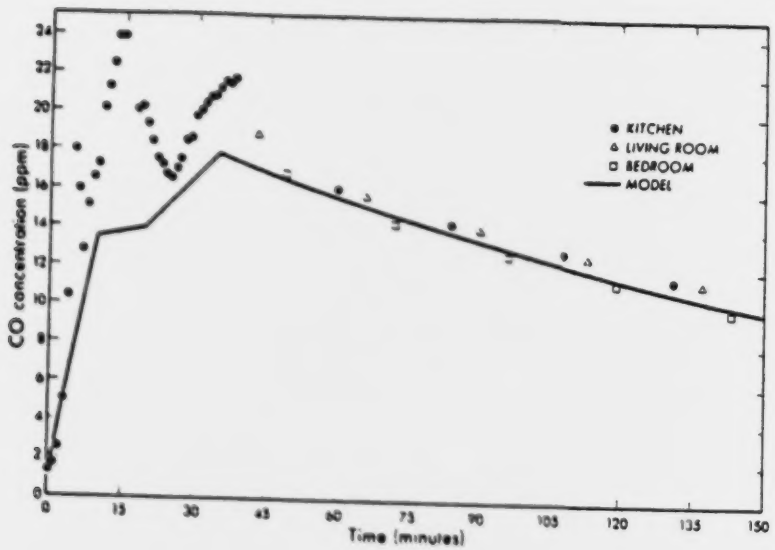

Figure 5a. Comparison of measured and model-derived CO concentrations in the research house of Figure 3 resulting from burning 425 liters of natural gas in the stove without mechanical ventilation (0.30 ACH). Outdoor CO concentration was less than 0.1 ppm (Traynor et al., 1982b).

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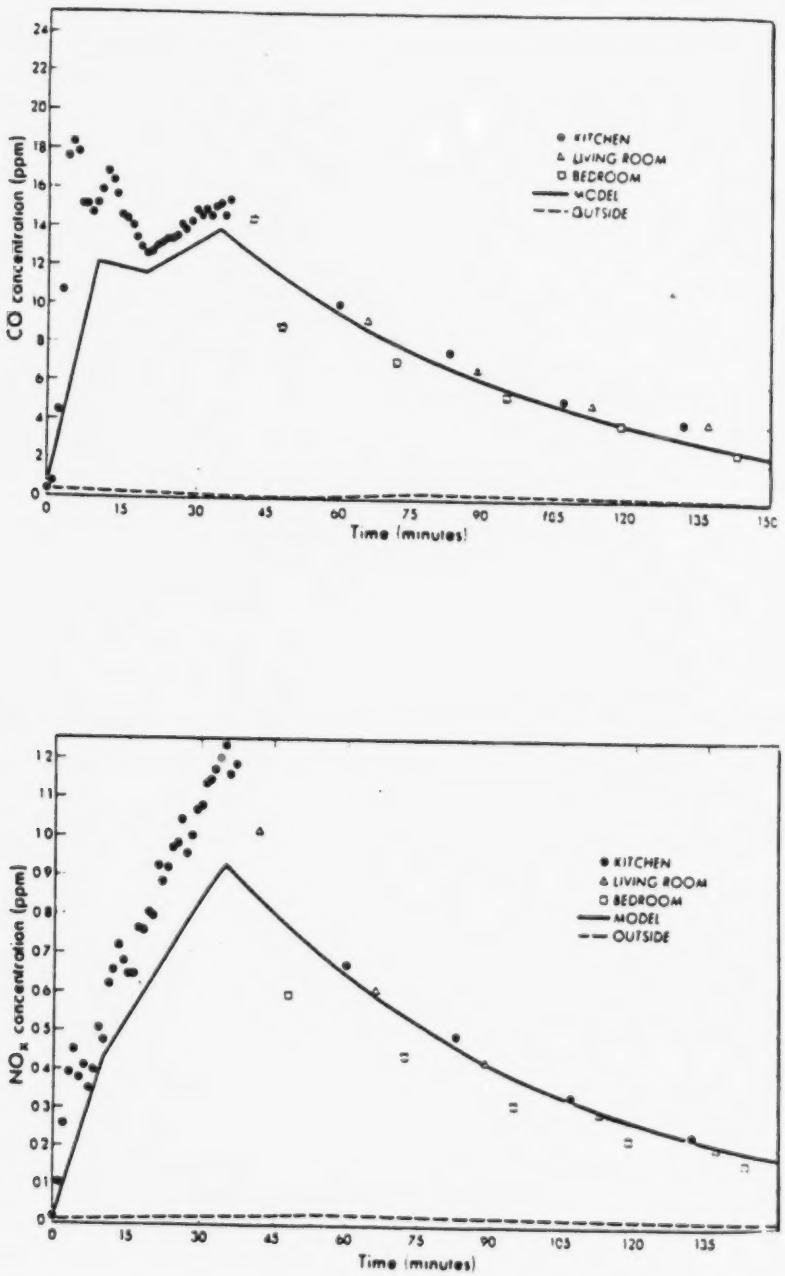

Figure 5b. Comparison of measured and model-derived CO and NO_x concentrations under the same conditions as Figure 5a but with whole-house mechanical ventilation (0.83 ACH) (Traynor et al., 1982b).

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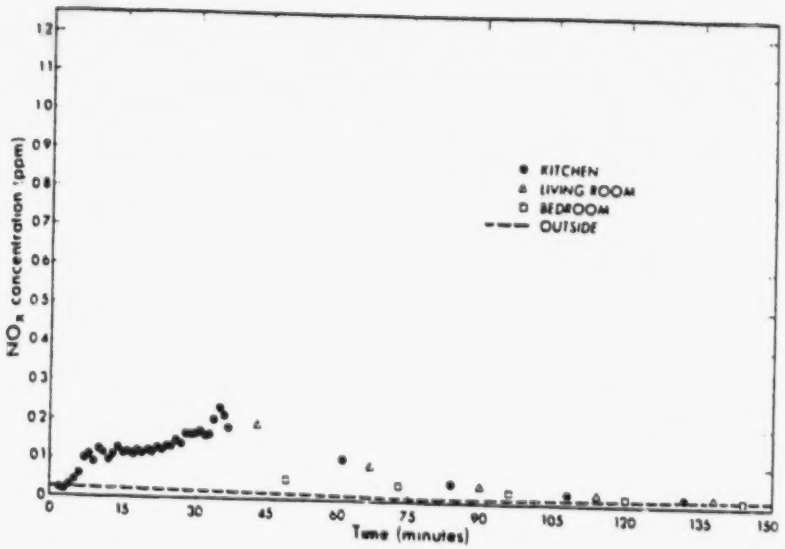

Figure 5c. Measured NO_x concentrations under the same conditions as Figure 5a but with operation of the ventilation fan on the stove (Traynor et al., 1982b).

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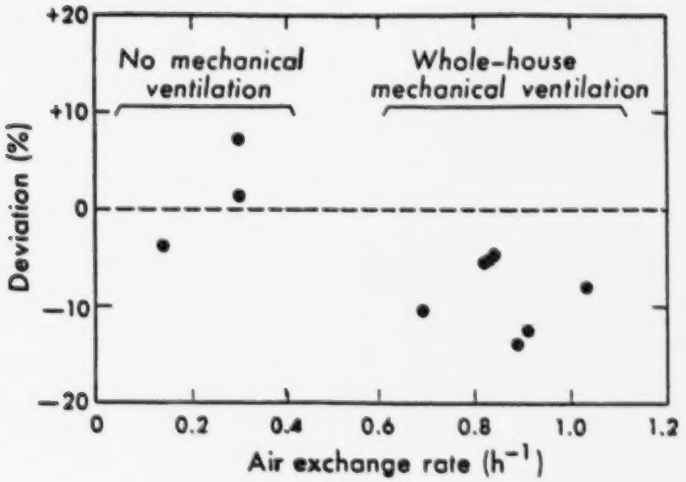

Figure 6. Deviation (%) of estimated pollutant peak based on measured values from pollutant peak derived from model, with and without mechanical ventilation (Traynor et al., 1982b).

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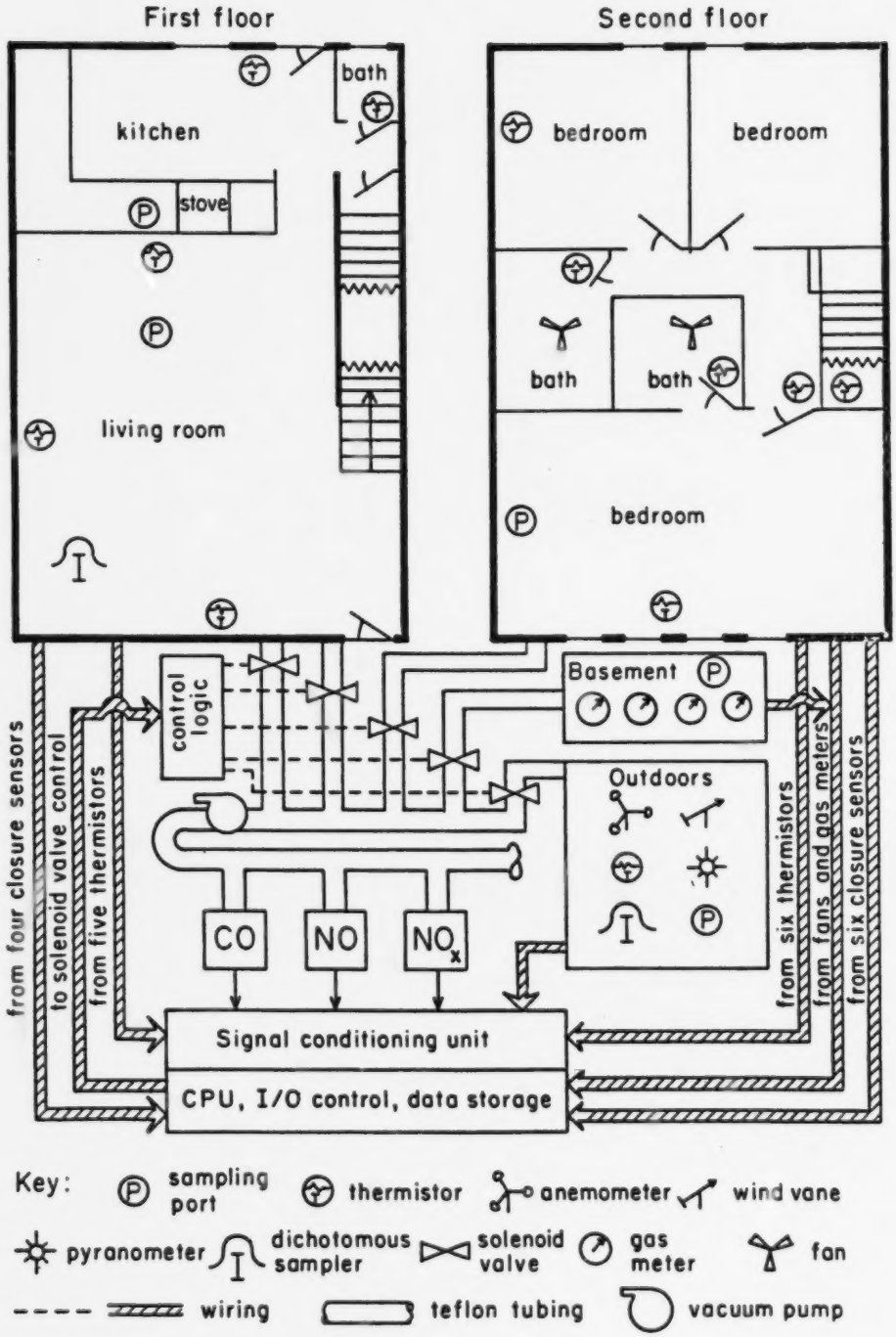


Figure 7. Floor plan, sampling locations, and data acquisition system for the townhouse studied by Borrazzo et al. (1986).

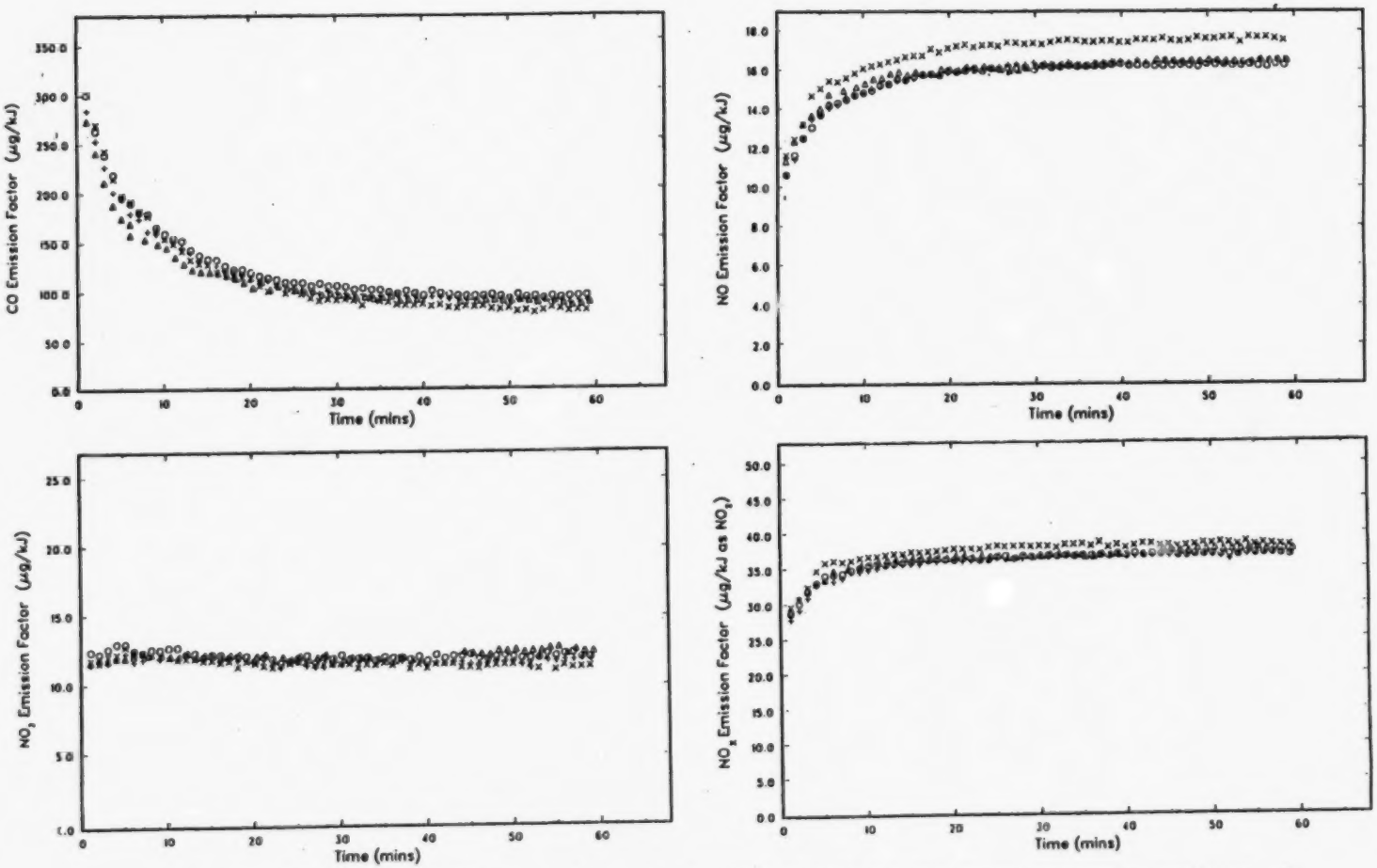
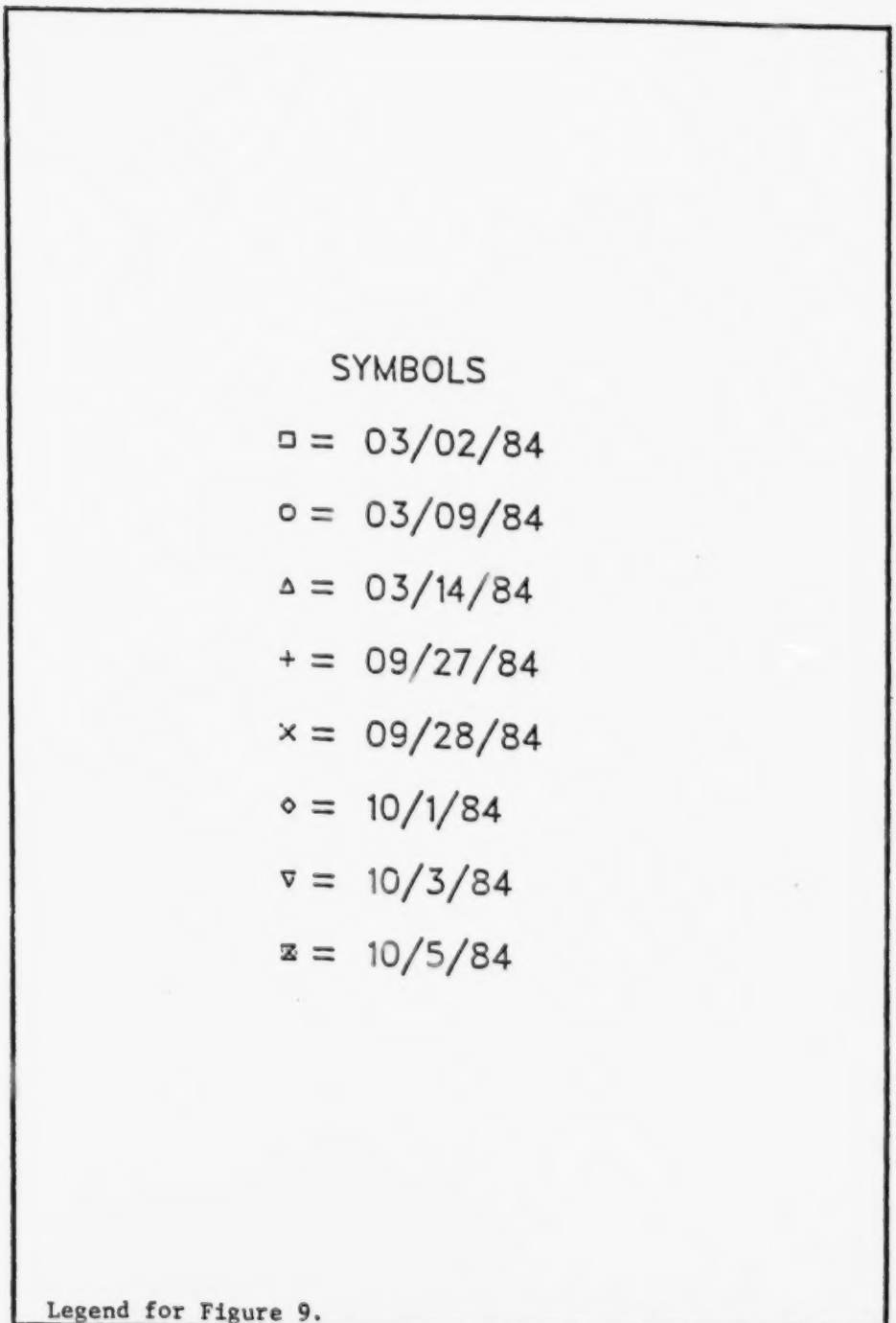


Figure 8. Emission factors for CO, NO, NO_2, and NO_x as a function of time for four experiments under conditions of similar temperature and humidity. Combustion began at time t=0. Data are for operation of the stove at a maximum gas flow rate (Borrazzo et al., 1986).



Legend for Figure 9.

Figure 9. Dimensionless concentrations of CO, NO, and NO_2 versus dimensionless time for eight pollutant concentration rise and decay experiments. The solid lines indicate model predictions based on minimum and maximum values of ψ at $\tau=\tau_b$ (Borrazzo et al., 1986).

ψ VS. τ

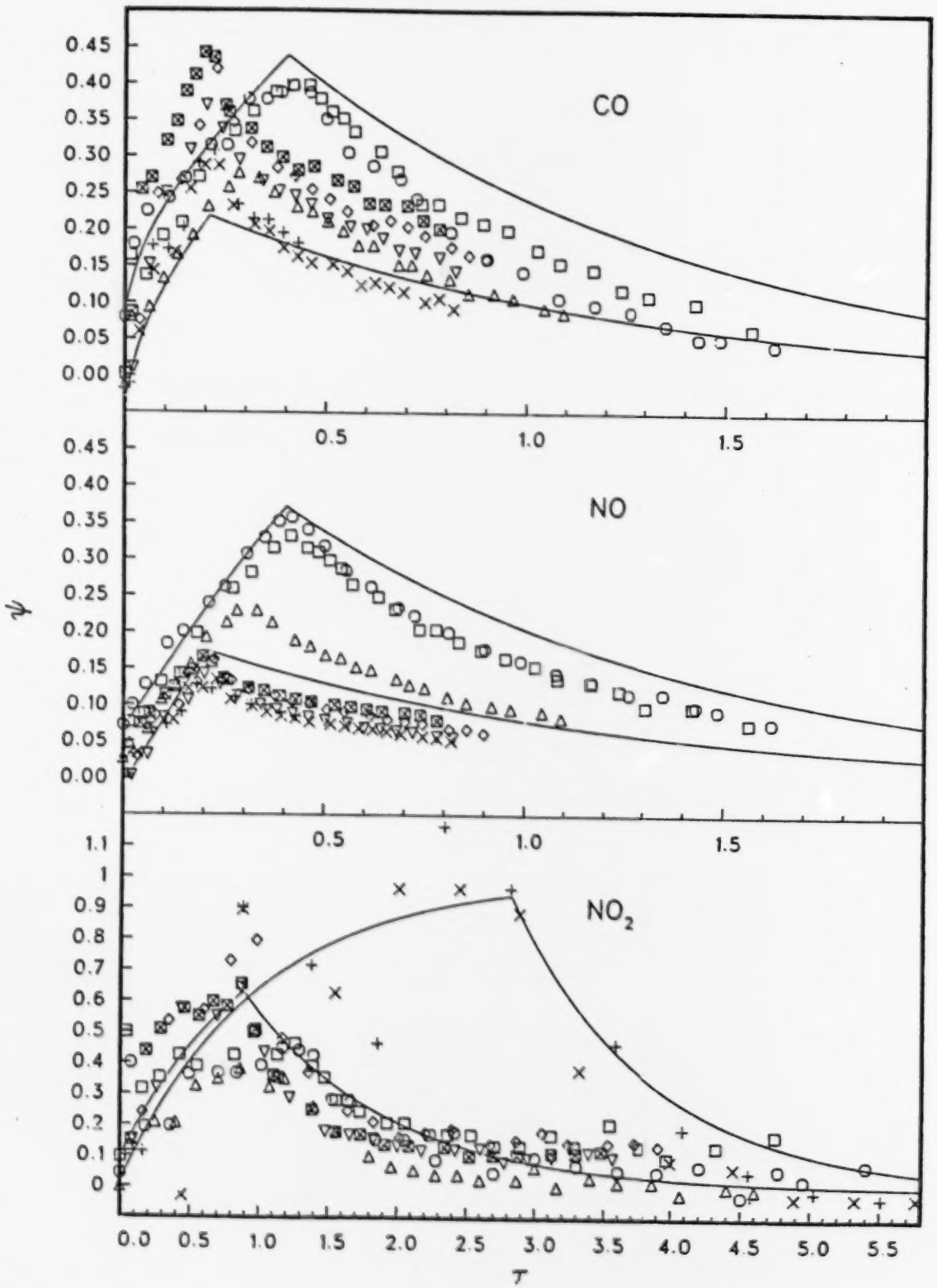


Figure 9

Appendix A: Database for emission factors measured at maximum gas flow rates

Column 1 - Reference number:

2 - Himmel and DeWerth (1974)
5 - Traynor et al. (1982a)
12 - Cote et al. (1974)
13 - Moschandreas et al. (1985)
14 - Borrazzo et al. (1986)
15 - Massachusetts Institute of Technology (1976)
16 - Fortmann et al. (1984)

Column 2 - Stove identification number

Column 3 - Number of burners tested for this observation

Column 4 - Position of burner relative to range:

1 - right front
2 - right rear
3 - left front
4 - left rear

Column 5 - Fuel type

1 - unspecified natural gas
4 - "lean" natural gas (36.59 MJ/m^3)
5 - "rich" natural gas (38.94 MJ/m^3)

Column 6 - Test method:

1, 2 - direct
3 - indirect

Column 7 - Primary aeration:

-1 - poorly adjusted
0 - not specified (assumed well)
1 - well adjusted

Column 8 - Number of replicates

Column 9 - Gas flow rate (kJ/min)

Column 10 - Emission factor (µg/kJ)

Column 11 - Standard deviation of measurements (µg/kJ)

Column 12 - Log_{10} EF

Column 13 - Values of normal distribution for this sample size

Column 14 - Burner Position Factor

0 - front
0.5 - not specified
1 - rear

Column 15 - Method of sampling factor

0 - direct
1 - indirect

Column 16 - Type of combustion factor

0 - poorly adjusted
1 - well adjusted

CO Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	202	1	1	1	2	1	1	158	11.12	0.000	1.04610	-1.18879	0.0	0	1
2	202	1	2	1	2	1	1	158	33.35	0.000	1.52310	-0.42607	1.0	0	1
2	202	1	3	1	2	1	1	158	14.29	0.000	1.15503	-0.98833	0.0	0	1
2	202	1	4	1	2	1	1	158	52.14	0.000	1.71717	-0.24792	1.0	0	1
2	203	1	1	1	2	1	1	158	28.58	0.000	1.45606	-0.48350	0.0	0	1
2	203	1	2	1	2	1	1	158	5.82	0.000	0.76492	-2.02980	1.0	0	1
2	203	1	3	1	2	1	1	158	9.26	0.000	0.96661	-1.47287	0.0	0	1
2	203	1	4	1	2	1	1	158	16.14	0.000	1.20790	-0.89692	1.0	0	1
2	204	1	1	1	2	1	1	158	7.94	0.000	0.89982	-1.79100	0.0	0	1
2	204	1	2	1	2	1	1	158	11.12	0.000	1.04610	-1.18879	1.0	0	1
2	204	1	3	1	2	1	1	158	63.52	0.000	1.80291	-0.07755	0.0	0	1
2	204	1	4	1	2	1	1	158	8.20	0.000	0.91381	-1.67460	1.0	0	1
2	205	1	1	1	2	1	1	158	104.28	0.000	2.01820	0.36312	0.0	0	1
2	205	1	2	1	2	1	1	158	16.41	0.000	1.21511	-0.86810	1.0	0	1
2	205	1	3	1	2	1	1	158	328.71	0.000	2.51681	1.33328	0.0	0	1
2	205	1	4	1	2	1	1	158	3.44	0.000	0.53656	-2.29112	1.0	0	1
2	206	1	1	1	2	1	1	158	115.39	0.000	2.06217	0.39789	0.0	0	1
2	206	1	2	1	2	1	1	158	53.99	0.000	1.73231	-0.22135	1.0	0	1
2	206	1	3	1	2	1	1	158	71.99	0.000	1.85727	0.03875	0.0	0	1
2	206	1	4	1	2	1	1	158	95.28	0.000	1.97900	0.22798	1.0	0	1
2	207	1	1	1	2	1	1	158	100.31	0.000	2.00134	0.32879	0.0	0	1
2	207	1	2	1	2	1	1	158	16.41	0.000	1.21511	-0.86810	1.0	0	1
2	207	1	3	1	2	1	1	158	19.06	0.000	1.28012	-0.75078	0.0	0	1
2	207	1	4	1	2	1	1	158	73.58	0.000	1.86676	0.05167	1.0	0	1
2	208	1	1	1	2	1	1	158	10.06	0.000	1.00260	-1.34933	0.0	0	1
2	208	1	2	1	2	1	1	158	31.76	0.000	1.50188	-0.46900	1.0	0	1
2	208	1	3	1	2	1	1	158	9.53	0.000	0.97909	-1.41728	0.0	0	1
2	208	1	4	1	2	1	1	158	10.59	0.000	1.02490	-1.27228	1.0	0	1
2	209	1	1	1	2	1	1	158	80.99	0.000	1.90843	0.11648	0.0	0	1
2	209	1	2	1	2	1	1	158	9.00	0.000	0.95424	-1.53339	1.0	0	1
2	209	1	3	1	2	1	1	158	80.46	0.000	1.90558	0.09051	0.0	0	1
2	209	1	4	1	2	1	1	158	32.55	0.000	1.51255	-0.45459	1.0	0	1
2	210	1	1	1	2	1	1	158	27.00	0.000	1.43136	-0.51283	0.0	0	1
2	210	1	2	1	2	1	1	158	49.76	0.000	1.69688	-0.27467	1.0	0	1
2	210	1	3	1	2	1	1	158	5.82	0.000	0.76492	-2.02980	0.0	0	1
2	210	1	4	1	2	1	1	158	16.94	0.000	1.22891	-0.83077	1.0	0	1
2	211	1	1	1	2	1	1	158	3.18	0.000	0.50243	-2.70765	0.0	0	1
2	211	1	2	1	2	1	1	158	11.12	0.000	1.04610	-1.18879	1.0	0	1
2	211	1	3	1	2	1	1	158	15.88	0.000	1.20085	-0.92652	0.0	0	1
2	211	1	4	1	2	1	1	158	8.47	0.000	0.92788	-1.60005	1.0	0	1
2	212	1	1	1	2	1	1	158	60.34	0.000	1.78061	-0.13601	0.0	0	1
2	212	1	2	1	2	1	1	158	12.70	0.000	1.10380	-1.05422	1.0	0	1
2	212	1	3	1	2	1	1	158	136.57	0.000	2.13536	0.58826	0.0	0	1
2	212	1	4	1	2	1	1	158	7.94	0.000	0.89982	-1.79100	1.0	0	1
2	213	1	1	1	2	1	1	158	168.32	0.000	2.22614	0.70007	0.0	0	1
2	213	1	2	1	2	1	1	158	13.50	0.000	1.13033	-1.02072	1.0	0	1
2	213	1	3	1	2	1	1	158	129.95	0.000	2.11378	0.54262	0.0	0	1
2	213	1	4	1	2	1	1	158	9.53	0.000	0.97909	-1.41728	1.0	0	1
2	214	1	1	1	2	1	1	158	20.11	0.000	1.30341	-0.69180	0.0	0	1
2	214	1	2	1	2	1	1	158	11.12	0.000	1.04610	-1.18879	1.0	0	1
2	214	1	3	1	2	1	1	158	60.34	0.000	1.78061	-0.13601	0.0	0	1
2	214	1	4	1	2	1	1	158	12.70	0.000	1.10380	-1.05422	1.0	0	1

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CO Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	215	1	1	1	2	1	1	158	14.29	0.000	1.15503	-0.98833	0.0	0	1
2	215	1	2	1	2	1	1	158	59.02	0.000	1.77100	-0.15559	1.0	0	1
2	215	1	3	1	2	1	1	158	20.11	0.000	1.30341	-0.69180	0.0	0	1
2	215	1	4	1	2	1	1	158	22.76	0.000	1.35717	-0.61155	1.0	0	1
2	216	1	1	1	2	1	1	158	9.00	0.000	0.95424	-1.53339	0.0	0	1
2	216	1	2	1	2	1	1	158	22.23	0.000	1.34694	-0.64314	1.0	0	1
2	216	1	3	1	2	1	1	158	18.79	0.000	1.27393	-0.76812	0.0	0	1
2	216	1	4	1	2	1	1	158	18.00	0.000	1.25527	-0.80353	1.0	0	1
2	218	1	2	1	2	1	1	158	3.44	0.000	0.53656	-2.29112	1.0	0	1
2	218	1	3	1	2	1	1	158	11.38	0.000	1.05614	-1.11287	0.0	0	1
2	218	1	4	1	2	1	1	158	24.35	0.000	1.38650	-0.54262	1.0	0	1
2	219	1	1	1	2	1	1	158	15.88	0.000	1.20085	-0.92652	0.0	0	1
2	219	1	2	1	2	1	1	158	22.76	0.000	1.35717	-0.61155	1.0	0	1
2	219	1	3	1	2	1	1	158	22.23	0.000	1.34694	-0.64314	0.0	0	1
2	219	1	4	1	2	1	1	158	10.32	0.000	1.01368	-1.30217	1.0	0	1
2	217	1	1	1	2	1	1	158	19.32	0.000	1.28601	-0.73366	0.0	0	1
2	217	1	2	1	2	1	1	158	8.20	0.000	0.91381	-1.67460	1.0	0	1
2	217	1	3	1	2	1	1	158	6.35	0.000	0.80277	-1.89718	0.0	0	1
2	202	1	1	1	2	-1	1	158	355.18	0.000	2.55045	1.39968	0.0	0	0
2	202	1	2	1	2	-1	1	158	837.92	0.000	2.92320	2.38916	1.0	0	0
2	202	1	3	1	2	-1	1	158	398.05	0.000	2.59994	1.55486	0.0	0	0
2	202	1	4	1	2	-1	1	158	845.06	0.000	2.92689	2.70765	1.0	0	0
2	203	1	1	1	2	-1	1	158	47.11	0.000	1.67311	-0.30162	0.0	0	0
2	203	1	2	1	2	-1	1	158	44.73	0.000	1.65060	-0.31518	1.0	0	0
2	203	1	3	1	2	-1	1	158	14.56	0.000	1.16316	-0.95696	0.0	0	0
2	203	1	4	1	2	-1	1	158	127.04	0.000	2.10394	0.51283	1.0	0	0
2	204	1	1	1	2	-1	1	158	217.29	0.000	2.33704	0.83999	0.0	0	0
2	204	1	2	1	2	-1	1	158	180.76	0.000	2.25710	0.71676	1.0	0	0
2	204	1	3	1	2	-1	1	158	150.33	0.000	2.17705	0.61939	0.0	0	0
2	204	1	4	1	2	-1	1	158	96.07	0.000	1.98259	0.26127	1.0	0	0
2	205	1	1	1	2	-1	1	158	331.89	0.000	2.52099	1.36573	0.0	0	0
2	205	1	2	1	2	-1	1	158	184.47	0.000	2.26593	0.73366	1.0	0	0
2	205	1	3	1	2	-1	1	158	322.36	0.000	2.50834	1.30217	0.0	0	0
2	205	1	4	1	2	-1	1	158	165.41	0.000	2.21856	0.68358	1.0	0	0
2	206	1	1	1	2	-1	1	158	190.56	0.000	2.28003	0.76812	0.0	0	0
2	206	1	2	1	2	-1	1	158	78.34	0.000	1.89398	0.06461	1.0	0	0
2	206	1	3	1	2	-1	1	158	607.13	0.000	2.78328	2.08298	0.0	0	0
2	206	1	4	1	2	-1	1	158	103.48	0.000	2.01486	0.34247	1.0	0	0
2	207	1	1	1	2	-1	1	158	10.06	0.000	1.00260	-1.34933	0.0	0	0
2	207	1	2	1	2	-1	1	158	43.67	0.000	1.64018	-0.32879	1.0	0	0
2	207	1	3	1	2	-1	1	158	163.03	0.000	2.21227	0.66727	0.0	0	0
2	207	1	4	1	2	-1	1	158	33.88	0.000	1.52994	-0.41194	1.0	0	0
2	208	1	1	1	2	-1	1	158	66.43	0.000	1.82236	-0.03875	0.0	0	0
2	208	1	2	1	2	-1	1	158	11.12	0.000	1.04610	-1.18879	1.0	0	0
2	208	1	3	1	2	-1	1	158	125.45	0.000	2.09847	0.46900	0.0	0	0
2	208	1	4	1	2	-1	1	158	123.86	0.000	2.09293	0.45459	1.0	0	0
2	209	1	1	1	2	-1	1	158	238.46	0.000	2.37742	0.95696	0.0	0	0
2	209	1	2	1	2	-1	1	158	117.51	0.000	2.07007	0.42607	1.0	0	0
2	209	1	3	1	2	-1	1	158	318.92	0.000	2.50368	1.27228	0.0	0	0
2	209	1	4	1	2	-1	1	158	225.76	0.000	2.35365	0.89692	1.0	0	0
2	210	1	1	1	2	-1	1	158	275.51	0.000	2.44014	1.04292	0.0	0	0
2	210	1	2	1	2	-1	1	158	202.47	0.000	2.30636	0.82162	1.0	0	0

CO Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	210	1	3	1	2	-1	1	158	399.11	0.000	2.60109	1.60005	0.0	0	0
2	210	1	4	1	2	-1	1	158	314.42	0.000	2.49751	1.21568	1.0	0	0
2	211	1	1	1	2	-1	1	158	155.62	0.000	2.19207	0.63518	0.0	0	0
2	211	1	2	1	2	-1	1	158	104.28	0.000	2.01820	0.36312	1.0	0	0
2	211	1	3	1	2	-1	1	158	90.51	0.000	1.95670	0.19495	0.0	0	0
2	211	1	4	1	2	-1	1	158	16.94	0.000	1.22891	-0.83077	1.0	0	0
2	212	1	1	1	2	-1	1	158	312.83	0.000	2.49531	1.16273	0.0	0	0
2	212	1	2	1	2	-1	1	158	86.54	0.000	1.93722	0.15559	1.0	0	0
2	212	1	3	1	2	-1	1	158	404.93	0.000	2.60738	1.70161	0.0	0	0
2	212	1	4	1	2	-1	1	158	297.22	0.000	2.47308	1.08896	1.0	0	0
2	213	1	1	1	2	-1	1	158	228.14	0.000	2.35820	0.93657	0.0	0	0
2	213	1	2	1	2	-1	1	158	298.54	0.000	2.47500	1.11287	1.0	0	0
2	213	1	3	1	2	-1	1	158	786.31	0.000	2.89559	2.21091	0.0	0	0
2	213	1	4	1	2	-1	1	158	434.57	0.000	2.63806	1.89718	1.0	0	0
2	214	1	1	1	2	-1	1	158	305.68	0.000	2.48527	1.13745	0.0	0	0
2	214	1	2	1	2	-1	1	158	537.79	0.000	2.73061	1.98172	1.0	0	0
2	214	1	3	1	2	-1	1	158	411.28	0.000	2.61414	1.75965	0.0	0	0
2	214	1	4	1	2	-1	1	158	246.14	0.000	2.39118	0.99901	1.0	0	0
2	215	1	1	1	2	-1	1	158	95.28	0.000	1.97900	0.22798	0.0	0	0
2	215	1	2	1	2	-1	1	158	93.69	0.000	1.97169	0.20813	1.0	0	0
2	215	1	3	1	2	-1	1	158	69.34	0.000	1.84098	0.00646	0.0	0	0
2	215	1	4	1	2	-1	1	158	69.34	0.000	1.84098	0.00646	1.0	0	0
2	216	1	1	1	2	-1	1	158	127.04	0.000	2.10394	0.51283	0.0	0	0
2	216	1	2	1	2	-1	1	158	294.30	0.000	2.46879	1.06566	1.0	0	0
2	216	1	3	1	2	-1	1	158	222.32	0.000	2.34698	0.85865	0.0	0	0
2	216	1	4	1	2	-1	1	158	369.47	0.000	2.56758	1.51260	1.0	0	0
2	218	1	2	1	2	-1	1	158	199.03	0.000	2.29892	0.78570	1.0	0	0
2	218	1	3	1	2	-1	1	158	69.61	0.000	1.84267	0.02583	0.0	0	0
2	218	1	4	1	2	-1	1	158	141.33	0.000	2.15023	0.60375	1.0	0	0
2	219	1	1	1	2	-1	1	158	134.98	0.000	2.13027	0.55770	0.0	0	0
2	219	1	2	1	2	-1	1	158	118.57	0.000	2.07397	0.44029	1.0	0	0
2	219	1	3	1	2	-1	1	158	85.75	0.000	1.93323	0.14253	0.0	0	0
2	219	1	4	1	2	-1	1	158	82.57	0.000	1.91682	0.12949	1.0	0	0
2	217	1	1	1	2	-1	1	158	368.67	0.000	2.56664	1.47287	0.0	0	0
2	217	1	2	1	2	-1	1	158	79.66	0.000	1.90124	0.07755	1.0	0	0
2	217	1	3	1	2	-1	1	158	54.26	0.000	1.73448	-0.20813	0.0	0	0
2	208	1	0	1	1	-1	1	167	127.04	0.000	2.10394	0.51283	0.5	0	0
5	501	2	0	1	3	0	5	153	200.00	34.000	2.30103	0.80353	0.5	1	1
13	1301	1	3	4	1	1	4	156	22.82	4.306	1.35832	-0.58057	0.0	0	1
13	1301	1	3	5	1	1	3	150	26.27	0.861	1.41946	-0.52767	0.0	0	1
13	1301	1	4	4	1	1	3	152	53.39	4.306	1.72746	-0.23462	1.0	0	1
13	1301	1	4	5	1	1	3	140	32.73	18.085	1.51495	-0.44029	1.0	0	1
13	1301	1	1	4	1	1	2	151	58.13	7.751	1.76440	-0.16868	0.0	0	1
13	1301	1	1	5	1	1	4	151	55.12	14.210	1.74131	-0.19495	0.0	0	1
13	1301	1	2	4	1	1	3	140	80.52	7.751	1.90590	0.10349	1.0	0	1
13	1301	1	2	5	1	1	3	156	86.98	20.238	1.93942	0.16868	1.0	0	1
13	1302	1	3	4	1	1	6	167	34.45	6.028	1.53719	-0.39789	0.0	0	1
13	1302	1	3	5	1	1	4	174	23.25	1.722	1.36642	-0.55770	0.0	0	1
13	1302	1	4	4	1	1	5	160	19.81	3.875	1.29688	-0.71676	1.0	0	1
13	1302	1	4	5	1	1	4	162	18.52	3.875	1.26764	-0.78570	1.0	0	1
13	1302	1	1	4	1	1	4	164	68.03	3.445	1.83270	-0.01291	0.0	0	1
13	1302	1	1	5	1	1	3	166	56.41	6.459	1.75136	-0.18180	0.0	0	1

CO Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
13	1302	1	2	4	1	1	4	166	37.03	2.153	1.56855	-0.37697	1.0	0	1
13	1302	1	2	5	1	1	3	172	22.82	1.722	1.35832	-0.58057	1.0	0	1
13	1303	1	3	4	1	1	14	155	39.62	10.765	1.59791	-0.35622	0.0	0	1
13	1303	1	3	5	1	1	9	157	20.67	5.598	1.31534	-0.66727	0.0	0	1
13	1303	1	4	4	1	1	11	154	157.60	19.377	2.19756	0.65114	1.0	0	1
13	1303	1	4	5	1	1	4	159	185.16	33.587	2.26755	0.75078	1.0	0	1
13	1303	1	1	4	1	1	6	156	27.56	6.459	1.44028	-0.49811	0.0	0	1
13	1303	1	1	5	1	1	4	157	37.03	12.487	1.56855	-0.37697	0.0	0	1
13	1303	1	2	4	1	1	6	153	63.30	18.946	1.80140	-0.09700	1.0	0	1
13	1303	1	2	5	1	1	4	156	51.24	5.598	1.70961	-0.26127	1.0	0	1
13	1301	1	3	1	1	-1	2	154	67.60	10.334	1.82995	-0.02583	0.0	0	0
13	1301	1	4	1	1	-1	2	148	97.75	6.459	1.99012	0.30162	1.0	0	0
13	1301	1	1	1	1	-1	5	151	226.93	3.014	2.35589	0.91656	0.0	0	0
13	1301	1	2	1	1	-1	2	157	313.91	7.751	2.49681	1.18879	1.0	0	0
13	1302	1	3	1	1	-1	2	171	315.63	3.445	2.49918	1.24348	0.0	0	0
13	1302	1	4	1	1	-1	2	163	63.30	2.584	1.80140	-0.09700	1.0	0	0
13	1302	1	1	1	1	-1	3	171	273.43	87.842	2.43685	1.02072	0.0	0	0
13	1302	1	2	1	1	-1	2	172	98.18	2.153	1.99202	0.31518	1.0	0	0
13	1303	1	3	1	1	-1	2	153	96.89	3.445	1.98628	0.27467	0.0	0	0
13	1303	1	4	1	1	-1	2	154	224.34	5.167	2.35091	0.87762	1.0	0	0
13	1303	1	1	1	1	-1	4	155	97.32	11.626	1.98820	0.28811	0.0	0	0
13	1303	1	2	1	1	-1	2	156	135.21	4.306	2.13101	0.57291	1.0	0	0
13	1301	1	1	1	3	1	12	158	40.48	9.473	1.60724	-0.34247	0.0	1	1
13	1302	1	1	1	3	1	12	158	65.88	7.320	1.81875	-0.05167	0.0	1	1
13	1303	1	1	1	3	1	12	158	243.72	27.128	2.38689	0.97777	0.0	1	1
13	1301	1	1	1	3	-1	12	158	400.89	133.917	2.60303	1.64874	0.0	1	0
13	1302	1	1	1	3	-1	12	158	415.96	77.939	2.61905	1.82418	0.0	1	0
13	1303	1	1	1	3	-1	12	158	367.30	34.448	2.56502	1.43532	0.0	1	0
13	1301	1	1	1	3	1	4	161	61.15	1.722	1.78640	-0.11648	0.0	1	1
12	1201	1	0	1	3	0	0	158	47.37	0.000	1.67550	-0.28811	0.5	1	1
12	1202	1	0	1	3	0	0	158	64.59	0.000	1.81017	-0.06461	0.5	1	1
16	1601	1	3	1	2	0	3	159	117.22	18.182	2.06900	0.41194	0.0	0	1
16	1601	1	1	1	2	0	3	159	95.69	40.670	1.98087	0.24792	0.0	0	1
16	1602	1	3	1	2	0	3	146	126.79	15.550	2.10308	0.48350	0.0	0	1
16	1602	1	1	1	2	0	2	138	114.83	16.507	2.06006	0.38393	0.0	0	1
14	1602	1	1	1	2	0	3	150	89.90	1.310	1.95376	0.18180	0.0	0	1
15	1501	1	0	1	1	0	0	158	11.63	0.000	1.06558	-1.08896	0.5	0	1

NO Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	202	1	2	1	2	1	1	158	25.61	0.0000	1.40841	1.48974	1.0	0	1
2	202	1	3	1	2	1	1	158	17.01	0.0000	1.23070	-0.11709	0.0	0	1
2	202	1	4	1	2	1	1	158	17.27	0.0000	1.23729	-0.02596	1.0	0	1
2	203	1	1	1	2	1	1	158	22.46	0.0000	1.35141	1.06235	0.0	0	1
2	203	1	2	1	2	1	1	158	26.26	0.0000	1.41929	1.89490	1.0	0	1
2	203	1	3	1	2	1	1	158	25.89	0.0000	1.41313	1.75723	0.0	0	1
2	203	1	4	1	2	1	1	158	21.69	0.0000	1.33626	0.95347	1.0	0	1
2	204	1	1	1	2	1	1	158	15.48	0.0000	1.18977	-0.50833	0.0	0	1
2	204	1	2	1	2	1	1	158	15.00	0.0000	1.17609	-0.66317	1.0	0	1
2	204	1	3	1	2	1	1	158	25.80	0.0000	1.41162	1.64621	0.0	0	1
2	204	1	4	1	2	1	1	158	21.13	0.0000	1.32490	0.76425	1.0	0	1
2	205	1	1	1	2	1	1	158	19.91	0.0000	1.29907	0.55333	0.0	0	1
2	205	1	2	1	2	1	1	158	24.24	0.0000	1.38453	1.26929	1.0	0	1
2	205	1	3	1	2	1	1	158	21.44	0.0000	1.33122	0.83628	0.0	0	1
2	205	1	4	1	2	1	1	158	23.45	0.0000	1.37014	1.21261	1.0	0	1
2	206	1	1	1	2	1	1	158	15.54	0.0000	1.19145	-0.46437	0.0	0	1
2	206	1	2	1	2	1	1	158	15.14	0.0000	1.18013	-0.59949	1.0	0	1
2	206	1	3	1	2	1	1	158	15.48	0.0000	1.18977	-0.50833	0.0	0	1
2	206	1	4	1	2	1	1	158	18.09	0.0000	1.25744	0.19597	1.0	0	1
2	207	1	1	1	2	1	1	158	9.90	0.0000	0.99564	-1.50992	0.0	0	1
2	207	1	2	1	2	1	1	158	25.12	0.0000	1.40002	1.43254	1.0	0	1
2	207	1	3	1	2	1	1	158	25.66	0.0000	1.40926	1.55222	0.0	0	1
2	207	1	4	1	2	1	1	158	21.55	0.0000	1.33345	0.91300	1.0	0	1
2	208	1	1	1	2	1	1	158	16.31	0.0000	1.21245	-0.25594	0.0	0	1
2	208	1	2	1	2	1	1	158	7.60	0.0000	0.88081	-1.75723	1.0	0	1
2	208	1	3	1	2	1	1	158	15.99	0.0000	1.20385	-0.39304	0.0	0	1
2	208	1	4	1	2	1	1	158	19.99	0.0000	1.30081	0.57625	1.0	0	1
2	209	1	1	1	2	1	1	158	20.47	0.0000	1.31112	0.64700	0.0	0	1
2	209	1	2	1	2	1	1	158	21.35	0.0000	1.32940	0.81787	1.0	0	1
2	209	1	3	1	2	1	1	158	14.26	0.0000	1.15412	-0.81787	0.0	0	1
2	209	1	4	1	2	1	1	158	25.69	0.0000	1.40976	1.59747	1.0	0	1
2	210	1	1	1	2	1	1	158	19.62	0.0000	1.29270	0.45713	0.0	0	1
2	210	1	2	1	2	1	1	158	25.86	0.0000	1.41263	1.69914	1.0	0	1
2	210	1	3	1	2	1	1	158	20.50	0.0000	1.31175	0.66317	0.0	0	1
2	210	1	4	1	2	1	1	158	16.25	0.0000	1.21085	-0.27613	1.0	0	1
2	211	1	1	1	2	1	1	158	20.64	0.0000	1.31471	0.71278	0.0	0	1
2	211	1	2	1	2	1	1	158	16.25	0.0000	1.21085	-0.27613	1.0	0	1
2	211	1	3	1	2	1	1	158	16.84	0.0000	1.22634	-0.18275	0.0	0	1
2	211	1	4	1	2	1	1	158	15.48	0.0000	1.18977	-0.50833	1.0	0	1
2	212	1	1	1	2	1	1	158	23.39	0.0000	1.36903	1.18568	0.0	0	1
2	212	1	2	1	2	1	1	158	23.25	0.0000	1.36642	1.15959	1.0	0	1
2	212	1	3	1	2	1	1	158	19.20	0.0000	1.28330	0.37903	0.0	0	1
2	212	1	4	1	2	1	1	158	23.22	0.0000	1.36586	1.13426	1.0	0	1
2	213	1	1	1	2	1	1	158	18.03	0.0000	1.25600	0.17616	0.0	0	1
2	213	1	2	1	2	1	1	158	29.09	0.0000	1.46374	2.20891	1.0	0	1
2	213	1	3	1	2	1	1	158	17.04	0.0000	1.23147	-0.09751	0.0	0	1
2	213	1	4	1	2	1	1	158	16.13	0.0000	1.20763	-0.32371	1.0	0	1
2	214	1	1	1	2	1	1	158	20.25	0.0000	1.30643	0.61517	0.0	0	1
2	214	1	2	1	2	1	1	158	22.86	0.0000	1.35908	1.10965	1.0	0	1
2	214	1	3	1	2	1	1	158	16.90	0.0000	1.22789	-0.14984	0.0	0	1
2	214	1	4	1	2	1	1	158	17.64	0.0000	1.24650	0.04544	1.0	0	1
2	215	1	1	1	2	1	1	158	24.10	0.0000	1.38202	1.24045	0.0	0	1

NO Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	215	1	2	1	2	1	1	158	29.04	0.0000	1.46300	2.08086	1.0	0	1
2	215	1	3	1	2	1	1	158	25.61	0.0000	1.40841	1.48974	0.0	0	1
2	215	1	4	1	2	1	1	158	20.62	0.0000	1.31429	0.69605	1.0	0	1
2	216	1	1	1	2	1	1	158	20.84	0.0000	1.31890	0.74687	0.0	0	1
2	216	1	2	1	2	1	1	158	21.55	0.0000	1.33345	0.91300	1.0	0	1
2	216	1	3	1	2	1	1	158	26.54	0.0000	1.42390	1.97952	0.0	0	1
2	216	1	4	1	2	1	1	158	25.07	0.0000	1.39915	1.39686	1.0	0	1
2	218	1	2	1	2	1	1	158	19.62	0.0000	1.29270	0.45713	1.0	0	1
2	218	1	3	1	2	1	1	158	19.23	0.0000	1.28398	0.40714	0.0	0	1
2	218	1	4	1	2	1	1	158	21.92	0.0000	1.34084	0.97432	1.0	0	1
2	219	1	1	1	2	1	1	158	10.61	0.0000	1.02572	-1.39686	0.0	0	1
2	219	1	2	1	2	1	1	158	19.65	0.0000	1.29336	0.47892	1.0	0	1
2	219	1	3	1	2	1	1	158	14.77	0.0000	1.16938	-0.71278	0.0	0	1
2	219	1	4	1	2	1	1	158	15.62	0.0000	1.19368	-0.44992	1.0	0	1
2	217	1	1	1	2	1	1	158	14.52	0.0000	1.16197	-0.78187	0.0	0	1
2	217	1	2	1	2	1	1	158	11.77	0.0000	1.07078	-1.26929	1.0	0	1
2	217	1	3	1	2	1	1	158	14.52	0.0000	1.16197	-0.78187	0.0	0	1
2	202	1	1	1	2	-1	1	158	16.22	0.0000	1.21005	-0.29644	0.0	0	0
2	202	1	2	1	2	-1	1	158	6.81	0.0000	0.83315	-2.08086	1.0	0	0
2	202	1	3	1	2	-1	1	158	20.76	0.0000	1.31723	0.72972	0.0	0	0
2	202	1	4	1	2	-1	1	158	13.81	0.0000	1.14019	-0.85498	1.0	0	0
2	203	1	1	1	2	-1	1	158	18.49	0.0000	1.26694	0.28289	0.0	0	0
2	203	1	2	1	2	-1	1	158	21.30	0.0000	1.32838	0.79974	1.0	0	0
2	203	1	3	1	2	-1	1	158	21.47	0.0000	1.33183	0.85498	0.0	0	0
2	203	1	4	1	2	-1	1	158	20.10	0.0000	1.30320	0.59949	1.0	0	0
2	204	1	1	1	2	-1	1	158	17.01	0.0000	1.23070	-0.11709	0.0	0	0
2	204	1	2	1	2	-1	1	158	19.71	0.0000	1.29469	0.49357	1.0	0	0
2	204	1	3	1	2	-1	1	158	15.11	0.0000	1.17926	-0.61517	0.0	0	0
2	204	1	4	1	2	-1	1	158	26.20	0.0000	1.41830	1.82183	1.0	0	0
2	205	1	1	1	2	-1	1	158	15.65	0.0000	1.19451	-0.43557	0.0	0	0
2	205	1	2	1	2	-1	1	158	21.55	0.0000	1.33345	0.91300	1.0	0	0
2	205	1	3	1	2	-1	1	158	13.61	0.0000	1.13386	-0.89332	0.0	0	0
2	205	1	4	1	2	-1	1	158	19.79	0.0000	1.29645	0.50833	1.0	0	0
2	206	1	1	1	2	-1	1	158	16.02	0.0000	1.20466	-0.37206	0.0	0	0
2	206	1	2	1	2	-1	1	158	20.56	0.0000	1.31302	0.67952	1.0	0	0
2	206	1	3	1	2	-1	1	158	6.64	0.0000	0.82217	-2.20891	0.0	0	0
2	206	1	4	1	2	-1	1	158	17.38	0.0000	1.24005	-0.00649	1.0	0	0
2	207	1	1	1	2	-1	1	158	24.44	0.0000	1.38810	1.29923	0.0	0	0
2	207	1	2	1	2	-1	1	158	19.99	0.0000	1.30081	0.57625	1.0	0	0
2	207	1	3	1	2	-1	1	158	12.68	0.0000	1.10312	-1.08570	0.0	0	0
2	207	1	4	1	2	-1	1	158	17.89	0.0000	1.25261	0.14984	1.0	0	0
2	208	1	1	1	2	-1	1	158	18.69	0.0000	1.27161	0.33744	0.0	0	0
2	208	1	2	1	2	-1	1	158	13.04	0.0000	1.11528	-1.01734	1.0	0	0
2	208	1	3	1	2	-1	1	158	15.20	0.0000	1.18184	-0.58396	0.0	0	0
2	208	1	4	1	2	-1	1	158	15.06	0.0000	1.17782	-0.64700	1.0	0	0
2	209	1	1	1	2	-1	1	158	6.61	0.0000	0.82020	-2.38730	0.0	0	0
2	209	1	2	1	2	-1	1	158	13.72	0.0000	1.13735	-0.87399	1.0	0	0
2	209	1	3	1	2	-1	1	158	8.11	0.0000	0.90902	-1.69914	0.0	0	0
2	209	1	4	1	2	-1	1	158	17.18	0.0000	1.23502	-0.07145	1.0	0	0
2	210	1	1	1	2	-1	1	158	7.20	0.0000	0.85733	-1.85715	0.0	0	0
2	210	1	2	1	2	-1	1	158	15.43	0.0000	1.18837	-0.53821	1.0	0	0
2	210	1	3	1	2	-1	1	158	14.86	0.0000	1.17202	-0.67952	0.0	0	0

NO Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	210	1	4	1	2	-1	1	158	11.65	0.0000	1.06633	-1.29923	1.0	0	0
2	211	1	1	1	2	-1	1	158	8.65	0.0000	0.93702	-1.55222	0.0	0	0
2	211	1	2	1	2	-1	1	158	14.24	0.0000	1.15351	-0.83628	1.0	0	0
2	211	1	3	1	2	-1	1	158	14.52	0.0000	1.16197	-0.78187	0.0	0	0
2	211	1	4	1	2	-1	1	158	16.45	0.0000	1.21617	-0.24254	1.0	0	0
2	212	1	1	1	2	-1	1	158	18.38	0.0000	1.26435	0.26939	0.0	0	0
2	212	1	2	1	2	-1	1	158	17.69	0.0000	1.24773	0.07145	1.0	0	0
2	212	1	3	1	2	-1	1	158	12.65	0.0000	1.10209	-1.10965	0.0	0	0
2	212	1	4	1	2	-1	1	158	18.09	0.0000	1.25744	0.19597	1.0	0	0
2	213	1	1	1	2	-1	1	158	14.69	0.0000	1.16702	-0.72972	0.0	0	0
2	213	1	2	1	2	-1	1	158	18.60	0.0000	1.26951	0.31687	1.0	0	0
2	213	1	3	1	2	-1	1	158	18.32	0.0000	1.26293	0.25594	0.0	0	0
2	213	1	4	1	2	-1	1	158	17.24	0.0000	1.23654	-0.04544	1.0	0	0
2	214	1	1	1	2	-1	1	158	13.44	0.0000	1.12840	-0.93304	0.0	0	0
2	214	1	2	1	2	-1	1	158	4.14	0.0000	0.61700	-2.70604	1.0	0	0
2	214	1	3	1	2	-1	1	158	7.20	0.0000	0.85733	-1.85715	0.0	0	0
2	214	1	4	1	2	-1	1	158	10.18	0.0000	1.00775	-1.47014	1.0	0	0
2	215	1	1	1	2	-1	1	158	24.95	0.0000	1.39707	1.36287	0.0	0	0
2	215	1	2	1	2	-1	1	158	19.42	0.0000	1.28825	0.43557	1.0	0	0
2	215	1	3	1	2	-1	1	158	29.21	0.0000	1.46553	2.38730	0.0	0	0
2	215	1	4	1	2	-1	1	158	19.23	0.0000	1.28398	0.40714	1.0	0	0
2	216	1	1	1	2	-1	1	158	21.52	0.0000	1.33284	0.87399	0.0	0	0
2	216	1	2	1	2	-1	1	158	11.20	0.0000	1.04922	-1.33037	1.0	0	0
2	216	1	3	1	2	-1	1	158	16.02	0.0000	1.20466	-0.37206	0.0	0	0
2	216	1	4	1	2	-1	1	158	11.91	0.0000	1.07591	-1.24045	1.0	0	0
2	218	1	2	1	2	-1	1	158	19.23	0.0000	1.28398	0.40714	1.0	0	0
2	218	1	3	1	2	-1	1	158	18.77	0.0000	1.27346	0.36510	0.0	0	0
2	218	1	4	1	2	-1	1	158	12.96	0.0000	1.11260	-1.03958	1.0	0	0
2	219	1	1	1	2	-1	1	158	6.95	0.0000	0.84198	-1.97952	0.0	0	0
2	219	1	2	1	2	-1	1	158	10.55	0.0000	1.02325	-1.43254	1.0	0	0
2	219	1	3	1	2	-1	1	158	22.46	0.0000	1.35141	1.06235	0.0	0	0
2	219	1	4	1	2	-1	1	158	14.80	0.0000	1.17026	-0.69605	1.0	0	0
2	217	1	1	1	2	-1	1	158	15.91	0.0000	1.20167	-0.40714	0.0	0	0
2	217	1	2	1	2	-1	1	158	8.34	0.0000	0.92117	-1.64621	1.0	0	0
2	217	1	3	1	2	-1	1	158	12.08	0.0000	1.08207	-1.15959	0.0	0	0
2	208	1	0	1	1	-1	1	167	22.46	0.0000	1.35141	1.06235	0.5	0	0
13	1301	1	3	4	1	1	4	156	17.53	0.8612	1.24378	0.01947	0.0	0	1
13	1301	1	3	5	1	1	3	150	15.67	0.3014	1.19507	-0.42131	0.0	0	1
13	1301	1	4	4	1	1	3	152	16.92	0.2584	1.22840	-0.13672	1.0	0	1
13	1301	1	4	5	1	1	3	140	15.50	1.2487	1.19033	-0.47892	1.0	0	1
13	1301	1	1	4	1	1	2	151	17.05	0.3875	1.23172	-0.08447	0.0	0	1
13	1301	1	1	5	1	1	4	151	16.62	1.6793	1.22063	-0.21587	0.0	0	1
13	1301	1	2	4	1	1	3	140	16.06	0.6028	1.20575	-0.34433	1.0	0	1
13	1301	1	2	5	1	1	3	156	15.29	1.0334	1.18441	-0.56093	1.0	0	1
13	1302	1	3	4	1	1	6	167	17.61	0.2153	1.24576	0.03245	0.0	0	1
13	1302	1	3	5	1	1	4	174	17.70	0.3014	1.24797	0.09099	0.0	0	1
13	1302	1	4	4	1	1	5	160	16.06	0.0861	1.20575	-0.34433	1.0	0	1
13	1302	1	4	5	1	1	4	162	16.84	0.5167	1.22634	-0.18275	1.0	0	1
13	1302	1	1	4	1	1	4	164	16.88	0.3875	1.22737	-0.16298	0.0	0	1
13	1302	1	1	5	1	1	3	166	17.44	0.9043	1.24155	0.00649	0.0	0	1
13	1302	1	2	4	1	1	4	166	17.78	0.6028	1.24993	0.12363	1.0	0	1
13	1302	1	2	5	1	1	3	172	19.89	0.0431	1.29863	0.53069	1.0	0	1

NO Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
13	1303	1	3	4	1	1	14	155	17.96	0.3445	1.25431	0.16298	0.0	0	1
13	1303	1	3	5	1	1	9	157	18.56	0.2584	1.26858	0.29644	0.0	0	1
13	1303	1	4	4	1	1	11	154	17.70	0.2584	1.24797	0.09099	1.0	0	1
13	1303	1	4	5	1	1	4	159	17.27	0.3875	1.23729	-0.02596	1.0	0	1
13	1303	1	1	4	1	1	6	156	18.60	0.4306	1.26951	0.31687	0.0	0	1
13	1303	1	1	5	1	1	4	157	18.73	0.5598	1.27254	0.35124	0.0	0	1
13	1303	1	2	4	1	1	6	153	19.89	0.2153	1.29863	0.53069	1.0	0	1
13	1303	1	2	5	1	1	4	156	17.74	0.2584	1.24895	0.11056	1.0	0	1
13	1301	1	3	1	1	-1	2	154	18.26	0.0861	1.26150	0.24254	0.0	0	0
13	1301	1	4	1	1	-1	2	148	18.13	0.7320	1.25840	0.21587	1.0	0	0
13	1301	1	1	1	1	-1	5	151	12.75	0.4737	1.10551	-1.06235	0.0	0	0
13	1301	1	2	1	1	-1	2	157	11.11	0.1292	1.04571	-1.36287	1.0	0	0
13	1302	1	3	1	1	-1	2	171	13.48	0.1722	1.12969	-0.91300	0.0	0	0
13	1302	1	4	1	1	-1	2	163	13.43	0.0431	1.12808	-0.95347	1.0	0	0
13	1302	1	1	1	1	-1	3	171	13.09	0.3014	1.11694	-0.99560	0.0	0	0
13	1302	1	2	1	1	-1	2	172	17.83	0.1292	1.25115	0.13672	1.0	0	0
13	1303	1	3	1	1	-1	2	153	18.21	0.9904	1.26031	0.22919	0.0	0	0
13	1303	1	4	1	1	-1	2	154	15.29	0.0861	1.18441	-0.56093	1.0	0	0
13	1303	1	1	1	1	-1	4	155	17.65	0.4737	1.24674	0.05844	0.0	0	0
13	1303	1	2	1	1	-1	2	156	16.15	0.3875	1.20817	-0.31005	1.0	0	0
13	1301	1	1	1	3	1	12	158	17.22	2.5836	1.23603	-0.05844	0.0	1	1
13	1302	1	1	1	3	1	12	158	16.79	0.8612	1.22505	-0.20260	0.0	1	1
13	1303	1	1	1	3	1	12	158	15.07	2.1530	1.17811	-0.63101	0.0	1	1
13	1301	1	1	1	3	-1	12	158	12.06	2.1530	1.08135	-1.19903	0.0	1	0
13	1302	1	1	1	3	-1	12	158	8.61	1.7224	0.93500	-1.59747	0.0	1	0
13	1303	1	1	1	3	-1	12	158	12.06	2.1530	1.08135	-1.19903	0.0	1	0
13	1301	1	1	1	3	1	4	161	14.64	0.4306	1.16554	-0.74687	0.0	1	1
12	1201	1	0	1	3	0	0	158	21.96	0.0000	1.34163	0.99560	0.5	1	1
12	1202	1	0	1	3	0	0	158	31.00	0.0000	1.49136	2.70604	0.5	1	1
16	1601	1	3	1	2	0	3	159	13.40	2.1531	1.12710	-0.97432	0.0	0	1
16	1601	1	1	1	2	0	3	159	12.44	0.7177	1.09482	-1.13426	0.0	0	1
16	1602	1	3	1	2	0	3	146	21.29	2.8708	1.32818	0.78187	0.0	0	1
16	1602	1	1	1	2	0	2	138	22.01	1.4354	1.34262	1.01734	0.0	0	1
14	1602	1	1	1	2	0	3	150	16.60	0.1530	1.22011	-0.22919	0.0	0	1
15	1501	1	0	1	1	0	0	158	24.54	0.0000	1.38987	1.33037	0.5	0	1

NO_2 data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	202	1	1	1	2	1	1	158	7.87	0.0000	0.89597	-0.63101	0.0	0	1
2	202	1	2	1	2	1	1	158	8.26	0.0000	0.91698	-0.49357	1.0	0	1
2	202	1	3	1	2	1	1	158	7.96	0.0000	0.90091	-0.59171	0.0	0	1
2	202	1	4	1	2	1	1	158	8.83	0.0000	0.94596	-0.37903	1.0	0	1
2	203	1	1	1	2	1	1	158	7.48	0.0000	0.87390	-0.80877	0.0	0	1
2	203	1	2	1	2	1	1	158	7.04	0.0000	0.84757	-1.15959	1.0	0	1
2	203	1	3	1	2	1	1	158	8.13	0.0000	0.91009	-0.52321	0.0	0	1
2	203	1	4	1	2	1	1	158	6.91	0.0000	0.83948	-1.31464	1.0	0	1
2	204	1	1	1	2	1	1	158	8.09	0.0000	0.90795	-0.54575	0.0	0	1
2	204	1	2	1	2	1	1	158	7.00	0.0000	0.84510	-1.21261	1.0	0	1
2	204	1	3	1	2	1	1	158	10.91	0.0000	1.03782	0.18275	0.0	0	1
2	204	1	4	1	2	1	1	158	8.35	0.0000	0.92169	-0.44992	1.0	0	1
2	205	1	1	1	2	1	1	158	12.26	0.0000	1.08849	0.43557	0.0	0	1
2	205	1	2	1	2	1	1	158	10.13	0.0000	1.00561	-0.03245	1.0	0	1
2	205	1	3	1	2	1	1	158	14.65	0.0000	1.16584	0.90312	0.0	0	1
2	205	1	4	1	2	1	1	158	9.61	0.0000	0.98272	-0.15641	1.0	0	1
2	206	1	1	1	2	1	1	158	9.17	0.0000	0.96237	-0.26266	0.0	0	1
2	206	1	2	1	2	1	1	158	7.74	0.0000	0.88874	-0.66317	1.0	0	1
2	206	1	3	1	2	1	1	158	14.09	0.0000	1.14891	0.79974	0.0	0	1
2	206	1	4	1	2	1	1	158	7.48	0.0000	0.87390	-0.80877	1.0	0	1
2	207	1	1	1	2	1	1	158	14.65	0.0000	1.16584	0.90312	0.0	0	1
2	207	1	2	1	2	1	1	158	7.35	0.0000	0.86629	-0.92297	1.0	0	1
2	207	1	3	1	2	1	1	158	6.70	0.0000	0.82607	-1.48974	0.0	0	1
2	207	1	4	1	2	1	1	158	9.39	0.0000	0.97267	-0.21587	1.0	0	1
2	208	1	1	1	2	1	1	158	6.30	0.0000	0.79934	-1.85715	0.0	0	1
2	208	1	2	1	2	1	1	158	9.44	0.0000	0.97497	-0.20260	1.0	0	1
2	208	1	3	1	2	1	1	158	7.39	0.0000	0.86864	-0.86444	0.0	0	1
2	208	1	4	1	2	1	1	158	5.70	0.0000	0.75587	-2.70604	1.0	0	1
2	209	1	1	1	2	1	1	158	13.22	0.0000	1.12123	0.67132	0.0	0	1
2	209	1	2	1	2	1	1	158	7.83	0.0000	0.89376	-0.64700	1.0	0	1
2	209	1	3	1	2	1	1	158	10.87	0.0000	1.03623	0.16298	0.0	0	1
2	209	1	4	1	2	1	1	158	7.44	0.0000	0.87157	-0.83628	1.0	0	1
2	210	1	1	1	2	1	1	158	6.96	0.0000	0.84261	-1.26929	0.0	0	1
2	210	1	2	1	2	1	1	158	8.09	0.0000	0.90795	-0.54575	1.0	0	1
2	210	1	3	1	2	1	1	158	6.30	0.0000	0.79934	-1.85715	0.0	0	1
2	210	1	4	1	2	1	1	158	8.35	0.0000	0.92169	-0.44992	1.0	0	1
2	211	1	1	1	2	1	1	158	7.00	0.0000	0.84510	-1.21261	0.0	0	1
2	211	1	2	1	2	1	1	158	6.48	0.0000	0.81158	-1.64621	1.0	0	1
2	211	1	3	1	2	1	1	158	7.57	0.0000	0.87910	-0.76425	0.0	0	1
2	211	1	4	1	2	1	1	158	7.96	0.0000	0.90091	-0.59171	1.0	0	1
2	212	1	1	1	2	1	1	158	6.83	0.0000	0.83442	-1.39686	0.0	0	1
2	212	1	2	1	2	1	1	158	7.35	0.0000	0.86629	-0.92297	1.0	0	1
2	212	1	3	1	2	1	1	158	11.04	0.0000	1.04297	0.21587	0.0	0	1
2	212	1	4	1	2	1	1	158	7.22	0.0000	0.85854	-1.06235	1.0	0	1
2	213	1	1	1	2	1	1	158	11.83	0.0000	1.07298	0.36510	0.0	0	1
2	213	1	2	1	2	1	1	158	5.96	0.0000	0.77525	-2.20891	1.0	0	1
2	213	1	3	1	2	1	1	158	7.91	0.0000	0.89818	-0.61517	0.0	0	1
2	213	1	4	1	2	1	1	158	6.17	0.0000	0.79029	-1.97952	1.0	0	1
2	214	1	1	1	2	1	1	158	6.61	0.0000	0.82020	-1.55222	0.0	0	1
2	214	1	2	1	2	1	1	158	6.48	0.0000	0.81158	-1.64621	1.0	0	1
2	214	1	3	1	2	1	1	158	13.13	0.0000	1.11826	0.64700	0.0	0	1
2	214	1	4	1	2	1	1	158	7.30	0.0000	0.86332	-1.00641	1.0	0	1

NO_2 data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	215	1	1	1	2	1	1	158	11.44	0.0000	1.05843	0.32371	0.0	0	1
2	215	1	2	1	2	1	1	158	9.87	0.0000	0.99432	-0.08447	1.0	0	1
2	215	1	3	1	2	1	1	158	6.91	0.0000	0.83948	-1.31464	0.0	0	1
2	215	1	4	1	2	1	1	158	7.09	0.0000	0.85065	-1.12187	1.0	0	1
2	216	1	1	1	2	1	1	158	6.48	0.0000	0.81158	-1.64621	0.0	0	1
2	216	1	2	1	2	1	1	158	7.35	0.0000	0.86629	-0.92297	1.0	0	1
2	216	1	3	1	2	1	1	158	7.39	0.0000	0.86864	-0.86444	0.0	0	1
2	216	1	4	1	2	1	1	158	7.70	0.0000	0.88649	-0.68776	1.0	0	1
2	218	1	2	1	2	1	1	158	6.00	0.0000	0.77815	-2.08086	1.0	0	1
2	218	1	3	1	2	1	1	158	7.09	0.0000	0.85065	-1.12187	0.0	0	1
2	218	1	4	1	2	1	1	158	7.00	0.0000	0.84510	-1.21261	1.0	0	1
2	219	1	1	1	2	1	1	158	9.17	0.0000	0.96237	-0.26266	0.0	0	1
2	219	1	2	1	2	1	1	158	8.48	0.0000	0.92840	-0.40714	1.0	0	1
2	219	1	3	1	2	1	1	158	10.91	0.0000	1.03782	0.18275	0.0	0	1
2	219	1	4	1	2	1	1	158	9.17	0.0000	0.96237	-0.26266	1.0	0	1
2	217	1	1	1	2	1	1	158	8.17	0.0000	0.91222	-0.50833	0.0	0	1
2	217	1	2	1	2	1	1	158	6.39	0.0000	0.80550	-1.75723	1.0	0	1
2	217	1	3	1	2	1	1	158	5.83	0.0000	0.76567	-2.38730	0.0	0	1
2	202	1	1	1	2	-1	1	158	12.04	0.0000	1.08063	0.39304	0.0	0	0
2	202	1	2	1	2	-1	1	158	22.22	0.0000	1.34674	1.89490	1.0	0	0
2	202	1	3	1	2	-1	1	158	14.13	0.0000	1.15014	0.83628	0.0	0	0
2	202	1	4	1	2	-1	1	158	16.52	0.0000	1.21801	1.26929	1.0	0	0
2	203	1	1	1	2	-1	1	158	9.65	0.0000	0.98453	-0.13017	0.0	0	0
2	203	1	2	1	2	-1	1	158	6.83	0.0000	0.83442	-1.39686	1.0	0	0
2	203	1	3	1	2	-1	1	158	9.04	0.0000	0.95617	-0.33057	0.0	0	0
2	203	1	4	1	2	-1	1	158	10.52	0.0000	1.02202	0.05844	1.0	0	0
2	204	1	1	1	2	-1	1	158	10.70	0.0000	1.02938	0.11056	0.0	0	0
2	204	1	2	1	2	-1	1	158	10.57	0.0000	1.02407	0.07145	1.0	0	0
2	204	1	3	1	2	-1	1	158	11.70	0.0000	1.06819	0.35124	0.0	0	0
2	204	1	4	1	2	-1	1	158	9.70	0.0000	0.98677	-0.11056	1.0	0	0
2	205	1	1	1	2	-1	1	158	15.70	0.0000	1.19590	1.09759	0.0	0	0
2	205	1	2	1	2	-1	1	158	9.96	0.0000	0.99826	-0.05844	1.0	0	0
2	205	1	3	1	2	-1	1	158	12.61	0.0000	1.10072	0.54575	0.0	0	0
2	205	1	4	1	2	-1	1	158	7.61	0.0000	0.88138	-0.74687	1.0	0	0
2	206	1	1	1	2	-1	1	158	9.35	0.0000	0.97081	-0.22919	0.0	0	0
2	206	1	2	1	2	-1	1	158	8.04	0.0000	0.90526	-0.56858	1.0	0	0
2	206	1	3	1	2	-1	1	158	19.96	0.0000	1.30016	1.75723	0.0	0	0
2	206	1	4	1	2	-1	1	158	7.70	0.0000	0.88649	-0.68776	1.0	0	0
2	207	1	1	1	2	-1	1	158	7.65	0.0000	0.88366	-0.72123	0.0	0	0
2	207	1	2	1	2	-1	1	158	9.61	0.0000	0.98272	-0.15641	1.0	0	0
2	207	1	3	1	2	-1	1	158	15.91	0.0000	1.20167	1.13426	0.0	0	0
2	207	1	4	1	2	-1	1	158	7.30	0.0000	0.86332	-1.00641	1.0	0	0
2	208	1	1	1	2	-1	1	158	11.04	0.0000	1.04297	0.21587	0.0	0	0
2	208	1	2	1	2	-1	1	158	11.57	0.0000	1.06333	0.33744	1.0	0	0
2	208	1	3	1	2	-1	1	158	12.17	0.0000	1.08529	0.40714	0.0	0	0
2	208	1	4	1	2	-1	1	158	15.44	0.0000	1.18865	0.99560	1.0	0	0
2	209	1	1	1	2	-1	1	158	26.04	0.0000	1.41564	2.08086	0.0	0	0
2	209	1	2	1	2	-1	1	158	15.70	0.0000	1.19590	1.09759	1.0	0	0
2	209	1	3	1	2	-1	1	158	31.35	0.0000	1.49624	2.38730	0.0	0	0
2	209	1	4	1	2	-1	1	158	33.91	0.0000	1.53033	2.70604	1.0	0	0
2	210	1	1	1	2	-1	1	158	17.00	0.0000	1.23045	1.33037	0.0	0	0
2	210	1	2	1	2	-1	1	158	14.70	0.0000	1.16732	0.93304	1.0	0	0

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NO_2 Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	210	1	3	1	2	-1	1	158	22.00	0.0000	1.34242	1.82183	0.0	0	0
2	210	1	4	1	2	-1	1	158	14.61	0.0000	1.16465	0.87399	1.0	0	0
2	211	1	1	1	2	-1	1	158	15.65	0.0000	1.19451	1.05090	0.0	0	0
2	211	1	2	1	2	-1	1	158	16.00	0.0000	1.20412	1.17253	1.0	0	0
2	211	1	3	1	2	-1	1	158	14.22	0.0000	1.15290	0.85498	0.0	0	0
2	211	1	4	1	2	-1	1	158	6.83	0.0000	0.83442	-1.39686	1.0	0	0
2	212	1	1	1	2	-1	1	158	12.39	0.0000	1.09307	0.44992	0.0	0	0
2	212	1	2	1	2	-1	1	158	7.65	0.0000	0.88366	-0.72123	1.0	0	0
2	212	1	3	1	2	-1	1	158	18.44	0.0000	1.26576	1.59747	0.0	0	0
2	212	1	4	1	2	-1	1	158	16.00	0.0000	1.20412	1.17253	1.0	0	0
2	213	1	1	1	2	-1	1	158	13.09	0.0000	1.11694	0.63101	0.0	0	0
2	213	1	2	1	2	-1	1	158	13.35	0.0000	1.12548	0.70439	1.0	0	0
2	213	1	3	1	2	-1	1	158	22.31	0.0000	1.34850	1.97952	0.0	0	0
2	213	1	4	1	2	-1	1	158	14.09	0.0000	1.14891	0.79974	1.0	0	0
2	214	1	1	1	2	-1	1	158	13.87	0.0000	1.14208	0.76425	0.0	0	0
2	214	1	2	1	2	-1	1	158	14.74	0.0000	1.16850	0.95347	1.0	0	0
2	214	1	3	1	2	-1	1	158	15.65	0.0000	1.19451	1.05090	0.0	0	0
2	214	1	4	1	2	-1	1	158	10.44	0.0000	1.01870	0.03245	1.0	0	0
2	215	1	1	1	2	-1	1	158	10.74	0.0000	1.03100	0.12363	0.0	0	0
2	215	1	2	1	2	-1	1	158	11.35	0.0000	1.05500	0.28289	1.0	0	0
2	215	1	3	1	2	-1	1	158	8.30	0.0000	0.91908	-0.47892	0.0	0	0
2	215	1	4	1	2	-1	1	158	8.35	0.0000	0.92169	-0.44992	1.0	0	0
2	216	1	1	1	2	-1	1	158	11.04	0.0000	1.04297	0.21587	0.0	0	0
2	216	1	2	1	2	-1	1	158	14.78	0.0000	1.16967	0.97432	1.0	0	0
2	216	1	3	1	2	-1	1	158	13.44	0.0000	1.12840	0.72972	0.0	0	0
2	216	1	4	1	2	-1	1	158	14.09	0.0000	1.14891	0.79974	1.0	0	0
2	218	1	2	1	2	-1	1	158	15.48	0.0000	1.18977	1.01734	1.0	0	0
2	218	1	3	1	2	-1	1	158	10.65	0.0000	1.02735	0.08447	0.0	0	0
2	218	1	4	1	2	-1	1	158	9.13	0.0000	0.96047	-0.29644	1.0	0	0
2	219	1	1	1	2	-1	1	158	17.87	0.0000	1.25212	1.43254	0.0	0	0
2	219	1	2	1	2	-1	1	158	26.83	0.0000	1.42862	2.20891	1.0	0	0
2	219	1	3	1	2	-1	1	158	12.65	0.0000	1.10209	0.58396	0.0	0	0
2	219	1	4	1	2	-1	1	158	12.61	0.0000	1.10072	0.54575	1.0	0	0
2	217	1	1	1	2	-1	1	158	13.35	0.0000	1.12548	0.70439	0.0	0	0
2	217	1	2	1	2	-1	1	158	7.35	0.0000	0.86629	-0.92297	1.0	0	0
2	217	1	3	1	2	-1	1	158	10.00	0.0000	1.00000	-0.04544	0.0	0	0
2	208	1	0	1	1	-1	1	167	10.17	0.0000	1.00732	-0.00649	0.5	0	0
13	1301	1	3	4	1	1	4	156	7.49	0.9904	0.87448	-0.78187	0.0	0	1
13	1301	1	3	5	1	1	3	150	9.90	0.0861	0.99564	-0.07145	0.0	0	1
13	1301	1	4	4	1	1	3	152	7.23	0.0861	0.85914	-1.03958	1.0	0	1
13	1301	1	4	5	1	1	3	140	8.96	1.2918	0.95231	-0.36510	1.0	0	1
13	1301	1	1	4	1	1	2	151	8.44	0.6459	0.92634	-0.42131	0.0	0	1
13	1301	1	1	5	1	1	4	151	9.52	1.1626	0.97864	-0.18936	0.0	0	1
13	1301	1	2	4	1	1	3	140	8.66	0.6028	0.93752	-0.39304	1.0	0	1
13	1301	1	2	5	1	1	3	156	11.28	0.4306	1.05231	0.26939	1.0	0	1
13	1302	1	3	4	1	1	6	167	10.68	0.2584	1.02857	0.09751	0.0	0	1
13	1302	1	3	5	1	1	4	174	11.11	0.3014	1.04571	0.24254	0.0	0	1
13	1302	1	4	4	1	1	5	160	11.37	0.8612	1.05576	0.29644	1.0	0	1
13	1302	1	4	5	1	1	4	162	12.01	0.9904	1.07954	0.37903	1.0	0	1
13	1302	1	1	4	1	1	4	164	11.20	0.3875	1.04922	0.25594	0.0	0	1
13	1302	1	1	5	1	1	3	166	10.81	0.3445	1.03383	0.13672	0.0	0	1
13	1302	1	2	4	1	1	4	166	10.21	1.2487	1.00903	0.01298	1.0	0	1

NO_2 Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
13	1302	1	2	5	1	1	3	172	10.16	0.5167	1.00689	-0.01947	1.0	0	1
13	1303	1	3	4	1	1	14	155	9.04	0.1722	0.95617	-0.33057	0.0	0	1
13	1303	1	3	5	1	1	9	157	9.17	0.4306	0.96237	-0.26266	0.0	0	1
13	1303	1	4	4	1	1	11	154	10.46	0.3014	1.01953	0.04544	1.0	0	1
13	1303	1	4	5	1	1	4	159	10.85	0.3445	1.03543	0.14984	1.0	0	1
13	1303	1	1	4	1	1	6	156	9.82	0.3875	0.99211	-0.09751	0.0	0	1
13	1303	1	1	5	1	1	4	157	10.21	0.2584	1.00903	0.01298	0.0	0	1
13	1303	1	2	4	1	1	6	153	9.65	0.0861	0.98453	-0.13017	1.0	0	1
13	1303	1	2	5	1	1	4	156	9.60	0.3445	0.98227	-0.17616	1.0	0	1
13	1301	1	3	1	1	-1	2	154	11.41	0.2584	1.05729	0.31005	0.0	0	0
13	1301	1	4	1	1	-1	2	148	12.57	0.4306	1.09934	0.52321	1.0	0	0
13	1301	1	1	1	1	-1	5	151	17.18	0.6459	1.23502	1.36287	0.0	0	0
13	1301	1	2	1	1	-1	2	157	18.43	0.3014	1.26553	1.55222	1.0	0	0
13	1302	1	3	1	1	-1	2	171	18.39	0.2153	1.26458	1.50992	0.0	0	0
13	1302	1	4	1	1	-1	2	163	12.92	0.0861	1.11126	0.59949	1.0	0	0
13	1302	1	1	1	1	-1	3	171	18.52	0.3445	1.26764	1.64621	0.0	0	0
13	1302	1	2	1	1	-1	2	172	13.05	0.0431	1.11561	0.61517	1.0	0	0
13	1303	1	3	1	1	-1	2	153	12.62	0.6459	1.10106	0.56858	0.0	0	0
13	1303	1	4	1	1	-1	2	154	13.65	0.1722	1.13513	0.74687	1.0	0	0
13	1303	1	1	1	1	-1	4	155	12.53	0.7320	1.09795	0.50833	0.0	0	0
13	1303	1	2	1	1	-1	2	156	13.22	0.2153	1.12123	0.67132	1.0	0	0
13	1301	1	1	1	3	1	12	158	9.04	0.8612	0.95617	-0.33057	0.0	1	1
13	1302	1	1	1	3	1	12	158	12.49	0.4306	1.09656	0.47892	0.0	1	1
13	1303	1	1	1	3	1	12	158	9.04	1.7224	0.95617	-0.33057	0.0	1	1
13	1301	1	1	1	3	-1	12	158	16.36	2.1530	1.21378	1.21261	0.0	1	0
13	1302	1	1	1	3	-1	12	158	19.38	0.8612	1.28735	1.69914	0.0	1	0
13	1303	1	1	1	3	-1	12	158	12.49	2.1530	1.09656	0.47892	0.0	1	0
13	1301	1	1	1	3	1	4	161	7.32	0.4306	0.86451	-0.97432	0.0	1	1
12	1201	1	0	1	3	0	0	158	12.49	0.0000	1.09656	0.47892	0.5	1	1
12	1202	1	0	1	3	0	0	158	17.65	0.0000	1.24674	1.39686	0.5	1	1
16	1601	1	3	1	2	0	3	159	7.18	1.1962	0.85612	-1.08570	0.0	0	1
16	1601	1	1	1	2	0	3	159	6.70	0.9569	0.82607	-1.48974	0.0	0	1
16	1602	1	3	1	2	0	3	146	16.99	3.5885	1.23019	1.29923	0.0	0	1
16	1602	1	1	1	2	0	2	138	16.51	4.0670	1.21775	1.24045	0.0	0	1
14	1602	1	1	1	2	0	3	150	12.20	0.2650	1.08636	0.42131	0.0	0	1
15	1501	1	0	1	1	0	0	158	18.09	0.0000	1.25744	1.47014	0.5	0	1

NO_x Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
5	501	2	0	1	3	0	6	153	29.57	4.2714	1.47085	-1.83221	0.5	1	1
13	1301	1	3	4	1	1	4	156	34.36	2.2822	1.53605	-0.76934	0.0	0	1
13	1301	1	3	5	1	1	3	150	33.93	0.3875	1.53058	-0.84138	0.0	0	1
13	1301	1	4	4	1	1	3	152	33.20	0.4737	1.52114	-1.00085	1.0	0	1
13	1301	1	4	5	1	1	3	140	32.73	0.6028	1.51495	-1.19133	1.0	0	1
13	1301	1	1	4	1	1	2	151	34.58	0.0861	1.53882	-0.70115	0.0	0	1
13	1301	1	1	5	1	1	4	151	35.05	3.1434	1.54469	-0.57374	0.0	0	1
13	1301	1	2	4	1	1	3	140	32.90	1.0334	1.51720	-1.09110	1.0	0	1
13	1301	1	2	5	1	1	3	156	33.46	2.0238	1.52453	-0.91816	1.0	0	1
13	1302	1	3	4	1	1	6	167	37.12	1.3779	1.56961	-0.10362	0.0	0	1
13	1302	1	3	5	1	1	4	174	36.08	1.0334	1.55727	-0.34294	0.0	0	1
13	1302	1	4	4	1	1	5	160	34.96	1.3779	1.54357	-0.63613	1.0	0	1
13	1302	1	4	5	1	1	4	162	37.51	0.4737	1.57415	0.31560	1.0	0	1
13	1302	1	1	4	1	1	4	164	37.42	1.1626	1.57310	0.12966	0.0	0	1
13	1302	1	1	5	1	1	3	166	38.54	1.0334	1.58591	0.84138	0.0	0	1
13	1302	1	2	4	1	1	4	166	37.07	0.2153	1.56902	-0.18203	1.0	0	1
13	1302	1	2	5	1	1	3	172	40.13	0.5598	1.60347	1.30526	1.0	0	1
13	1303	1	3	4	1	1	14	155	36.69	0.7320	1.56455	-0.28850	0.0	0	1
13	1303	1	3	5	1	1	9	157	37.72	0.3445	1.57657	0.39844	0.0	0	1
13	1303	1	4	4	1	1	11	154	37.03	0.5598	1.56855	-0.23492	1.0	0	1
13	1303	1	4	5	1	1	4	159	37.33	0.8181	1.57206	0.02586	1.0	0	1
13	1303	1	1	4	1	1	6	156	38.07	0.5598	1.58058	0.57374	0.0	0	1
13	1303	1	1	5	1	1	4	157	37.42	1.0765	1.57310	0.12966	0.0	0	1
13	1303	1	2	4	1	1	6	153	39.40	0.9473	1.59550	1.09110	1.0	0	1
13	1303	1	2	5	1	1	4	156	37.42	0.8612	1.57310	0.12966	1.0	0	1
13	1301	1	3	1	1	-1	2	154	38.50	0.5598	1.58546	0.76934	0.0	0	0
13	1301	1	4	1	1	-1	2	148	38.41	1.4640	1.58444	0.70115	1.0	0	0
13	1301	1	1	1	1	-1	5	151	37.16	0.3875	1.57008	-0.02586	0.0	0	0
13	1301	1	2	1	1	-1	2	157	35.48	0.3014	1.54998	-0.45523	1.0	0	0
13	1302	1	3	1	1	-1	2	171	39.01	0.1292	1.59118	1.00085	0.0	0	0
13	1302	1	4	1	1	-1	2	163	38.67	0.3445	1.58737	0.91816	1.0	0	0
13	1302	1	1	1	1	-1	3	171	38.37	0.3875	1.58399	0.63613	0.0	0	0
13	1302	1	2	1	1	-1	2	172	40.39	0.1722	1.60627	1.43921	1.0	0	0
13	1303	1	3	1	1	-1	2	153	37.51	0.7320	1.57415	0.31560	0.0	0	0
13	1303	1	4	1	1	-1	2	154	37.12	0.0431	1.56961	-0.10362	1.0	0	0
13	1303	1	1	1	1	-1	4	155	39.79	0.0861	1.59977	1.19133	0.0	0	0
13	1303	1	2	1	1	-1	2	156	37.85	1.0765	1.57807	0.51356	1.0	0	0
13	1301	1	1	1	3	1	12	158	35.31	5.1672	1.54790	-0.51356	0.0	1	1
13	1302	1	1	1	3	1	12	158	37.46	1.7224	1.57357	0.23492	0.0	1	1
13	1303	1	1	1	3	1	12	158	32.30	5.1672	1.50920	-1.36917	0.0	1	1
13	1301	1	1	1	3	-1	12	158	35.74	5.1672	1.55315	-0.39844	0.0	1	0
13	1302	1	1	1	3	-1	12	158	32.30	2.1530	1.50920	-1.36917	0.0	1	0
13	1303	1	1	1	3	-1	12	158	29.71	4.7366	1.47290	-1.60529	0.0	1	0
13	1301	1	1	1	3	1	4	161	29.28	0.8612	1.46657	-2.22918	0.0	1	1
12	1201	1	0	1	3	0	0	158	46.07	0.0000	1.66342	1.60529	0.5	1	1
12	1202	1	0	1	3	0	0	158	65.02	0.0000	1.81305	2.22918	0.5	1	1
14	1602	1	1	1	2	0	3	150	37.80	0.2080	1.57749	0.45523	0.0	0	1
15	1501	1	0	1	1	0	0	158	55.55	0.0000	1.74468	1.83221	0.5	0	1

Appendix B: Normal and lognormal probability plots for emission factor data.

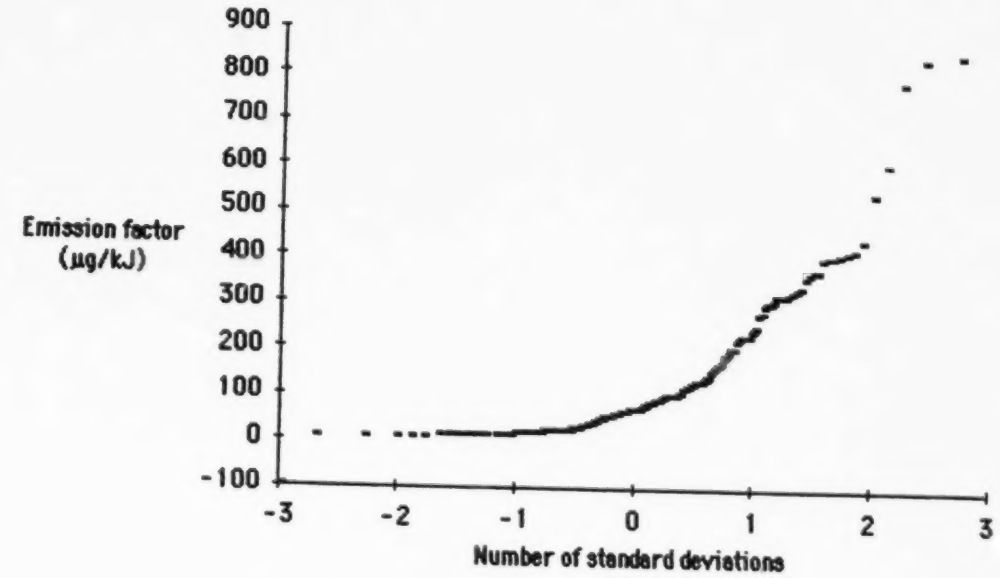


Fig. B-1. Normal probability plot for CO, all data.

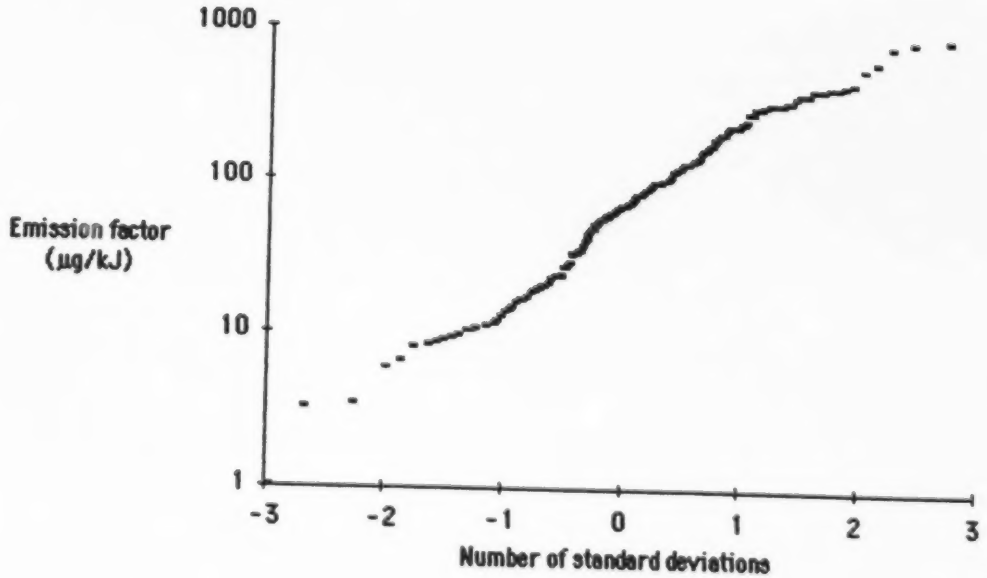


Fig. B-2. Log probability plot for CO, all data.

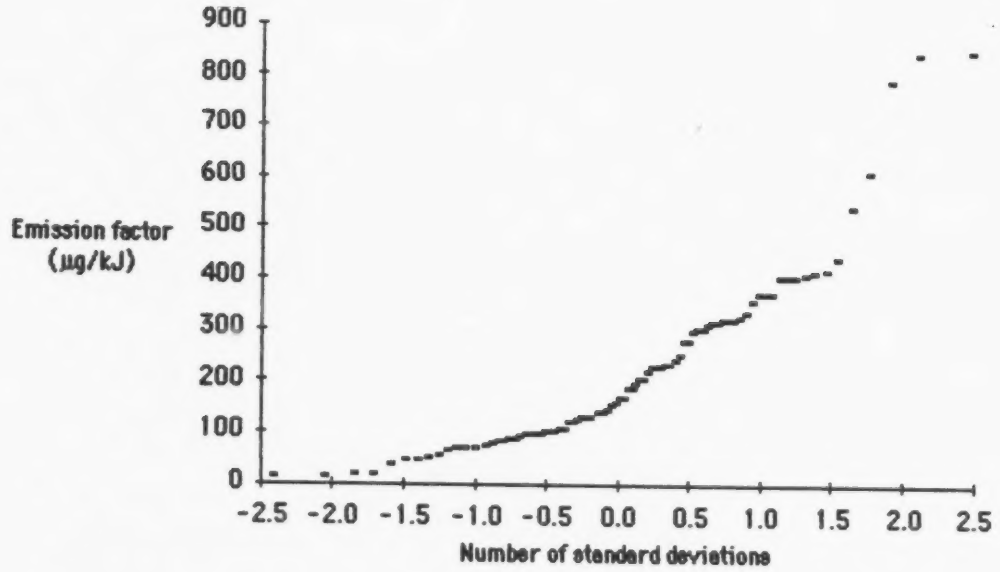


Fig. B-3. Normal probability plot for CO, all poorly adjusted combustion data.

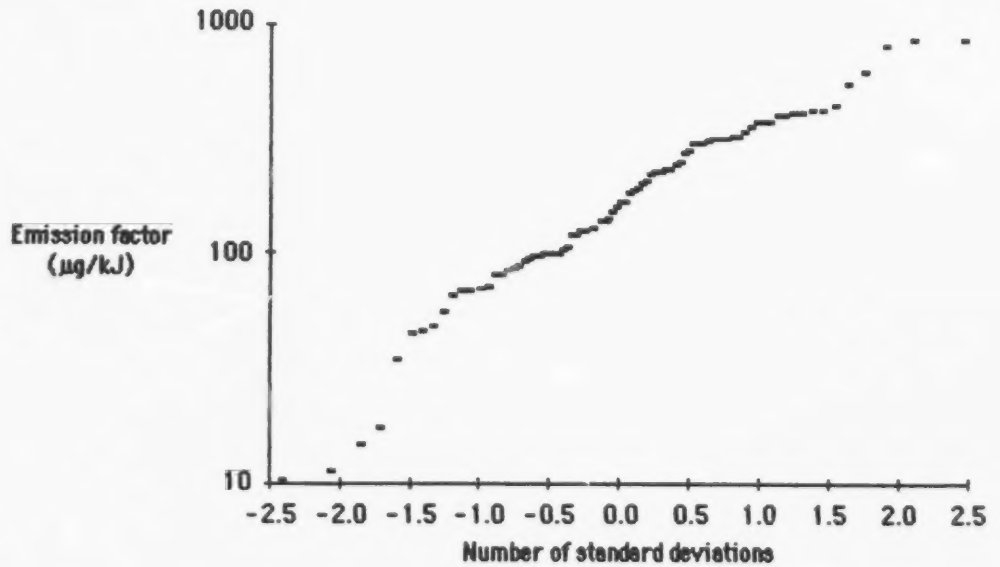


Fig. B-4. Log probability plot for CO, all poorly adjusted combustion data.

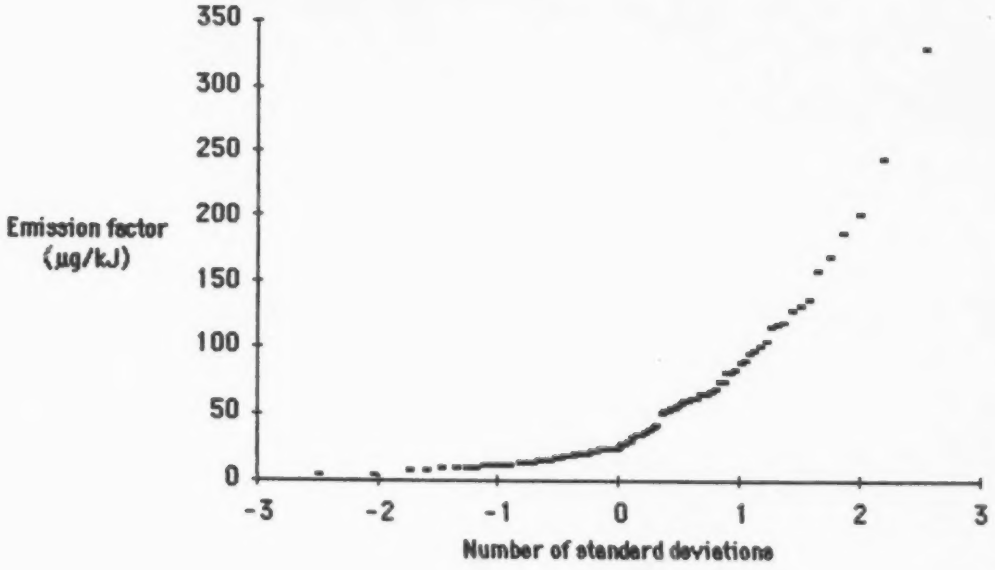


Fig. B-5. Normal probability plot for CO, all well adjusted combustion data.

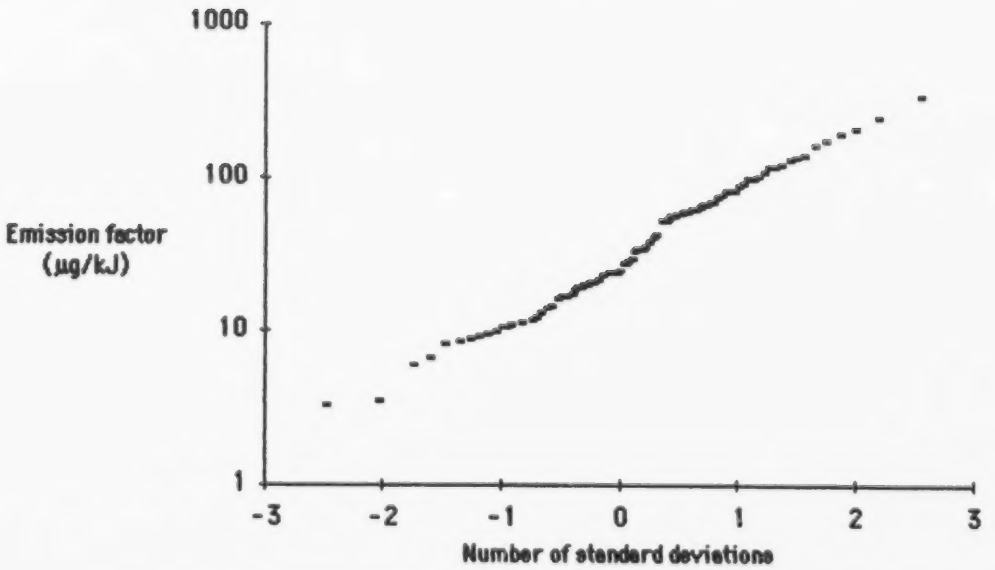


Fig. B-6. Log probability plot for CO, all well adjusted combustion data.

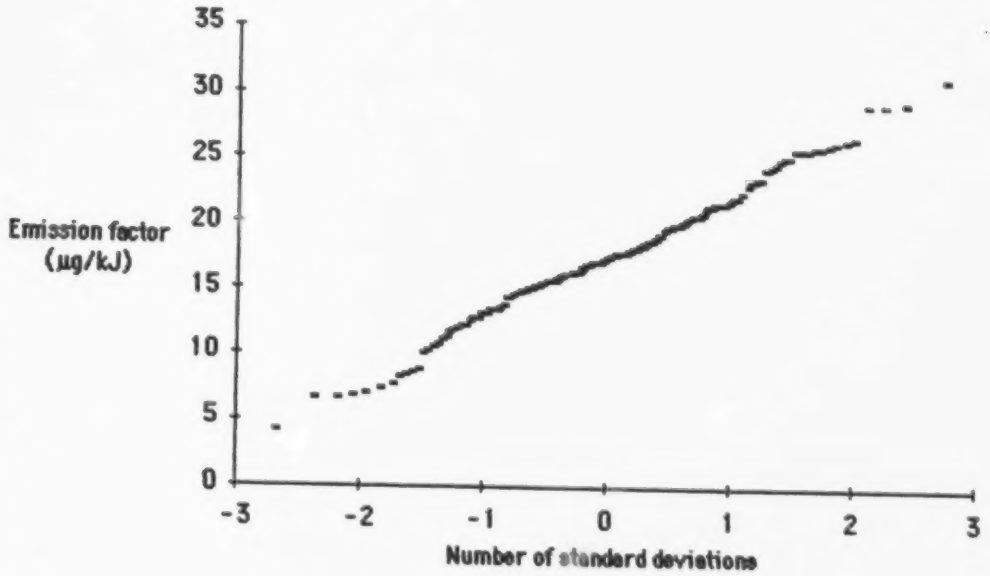


Fig. B-7. Normal probability plot for NO, all data.

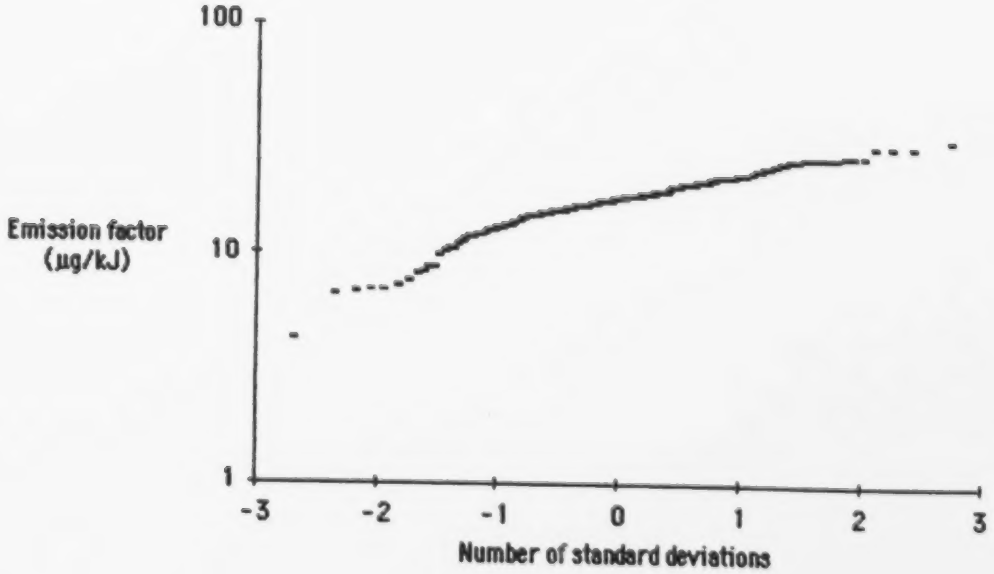


Fig. B-8. Log probability plot for NO, all data.

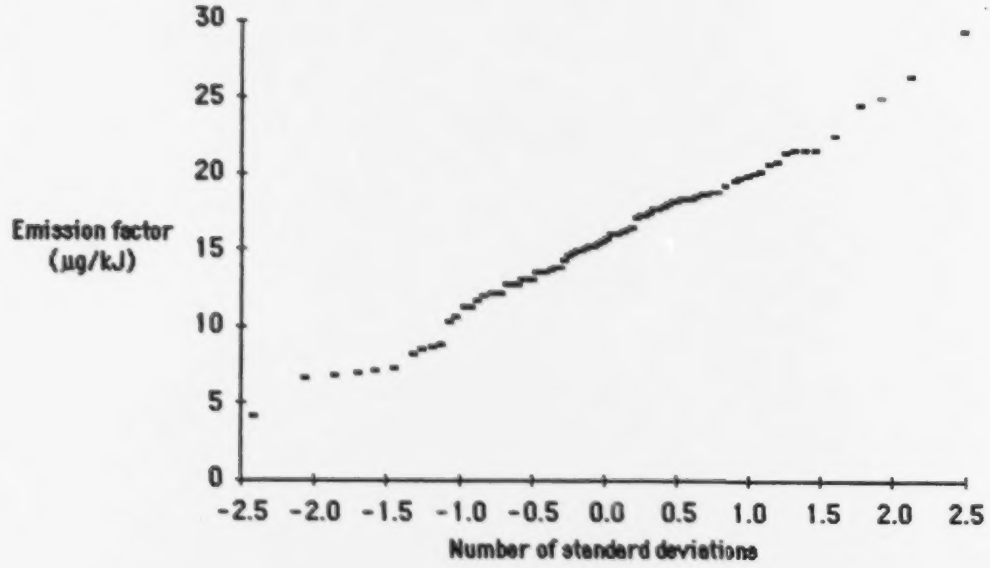


Fig. B-9. Normal probability plot for NO, all poorly adjusted combustion data.

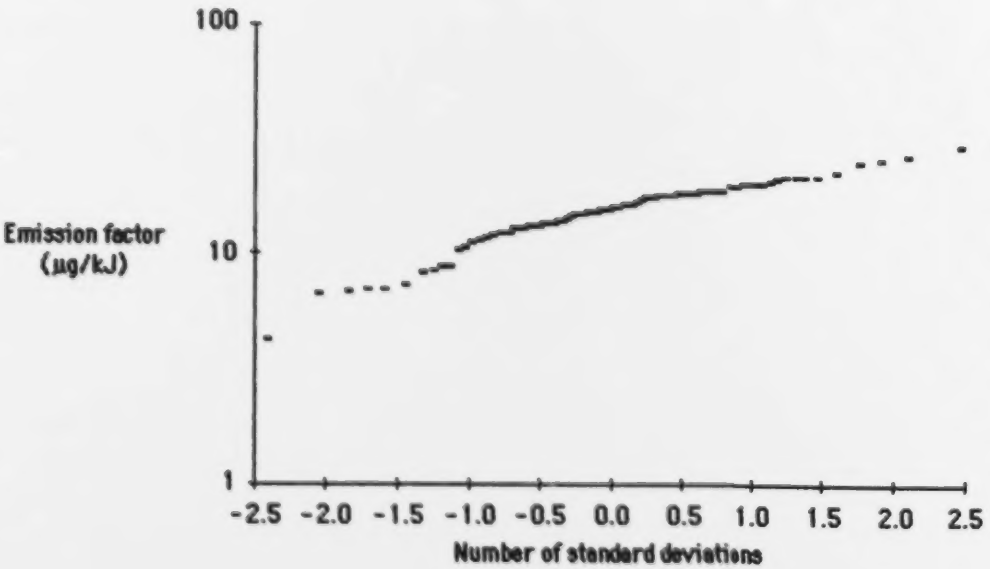


Fig. B-10. Log probability plot for NO, all poorly adjusted combustion data.

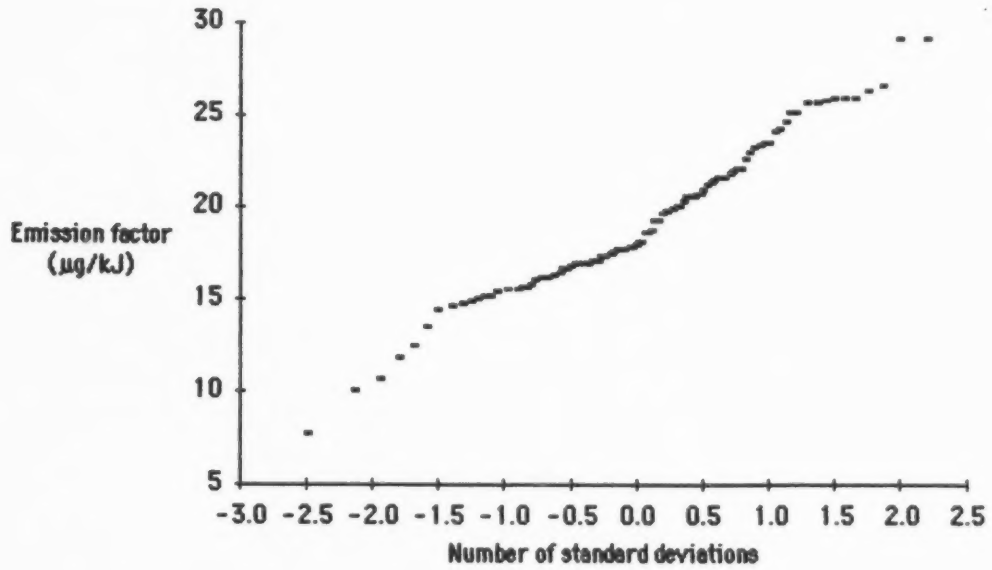


Fig. B-11. Normal probability plot for NO, all well adjusted combustion data.

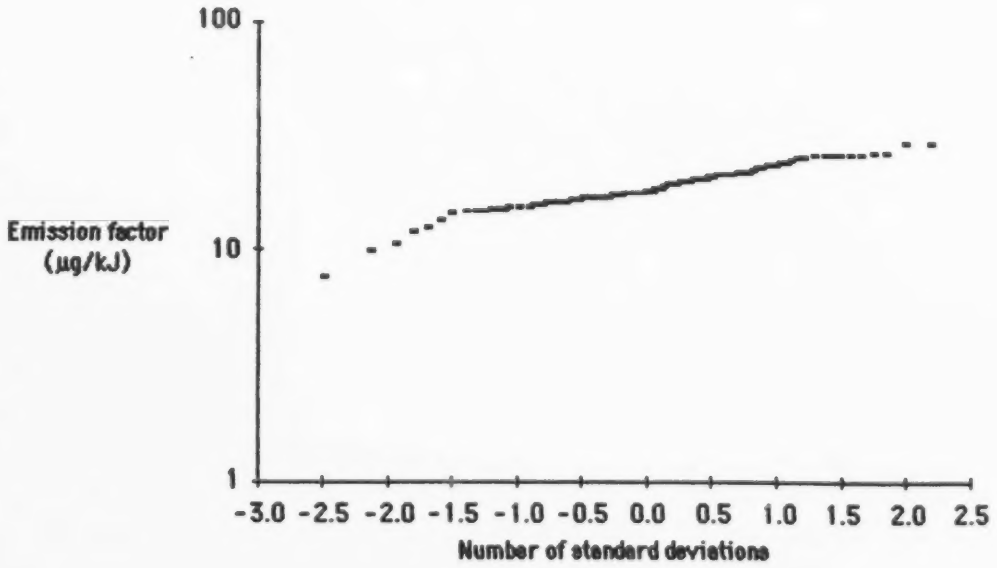


Fig. B-12. Log probability plot for NO, all well adjusted combustion data.

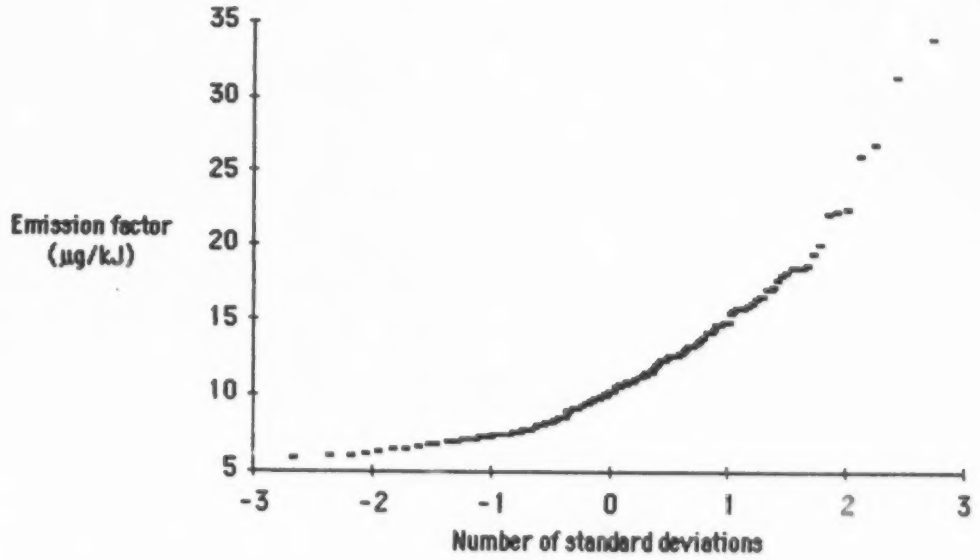


Fig. B-13. Normal probability plot for NO_2, all data.

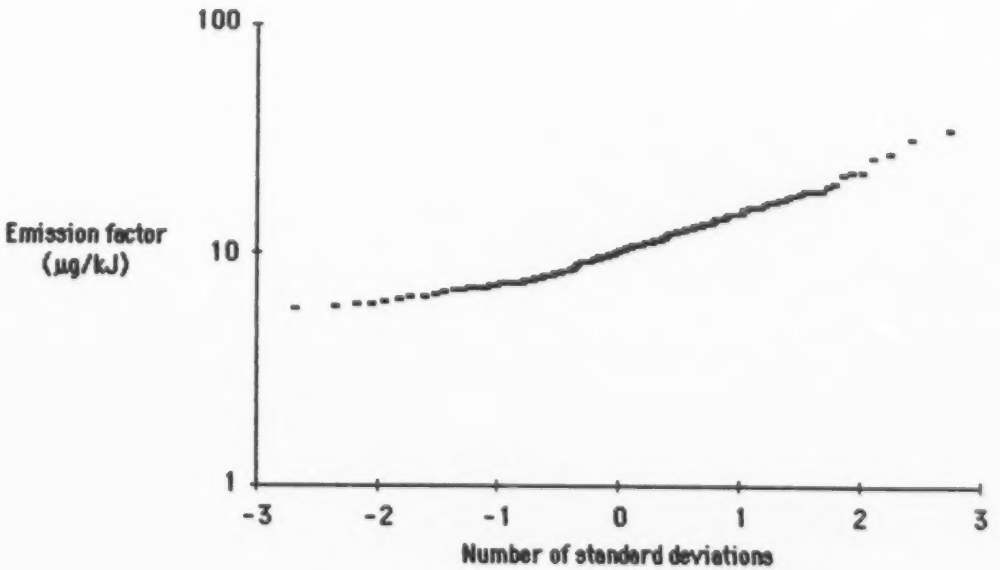


Fig. B-14. Log probability plot NO_2, all data.

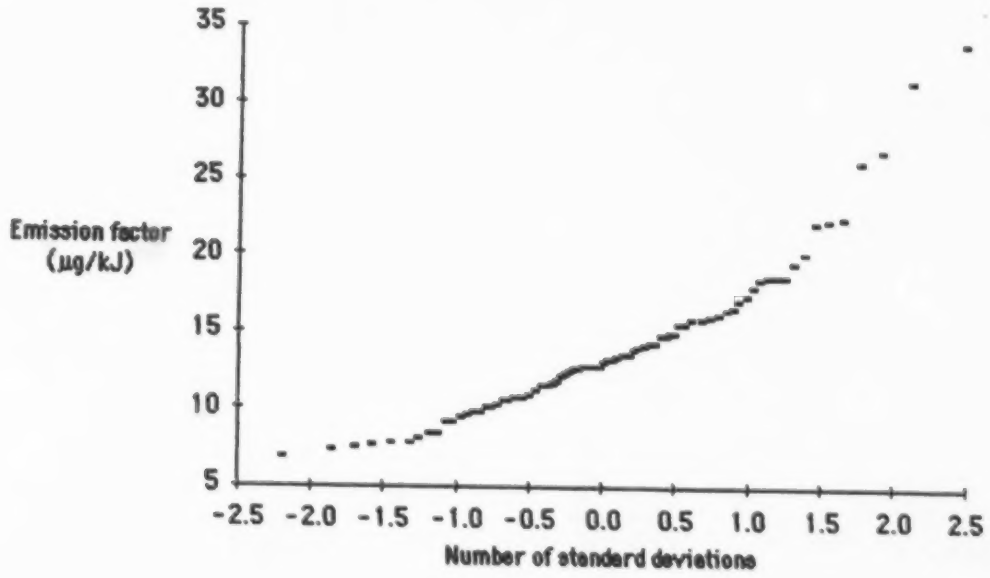


Fig. B-15. Normal probability plot NO_2 all well adjusted combustion data.

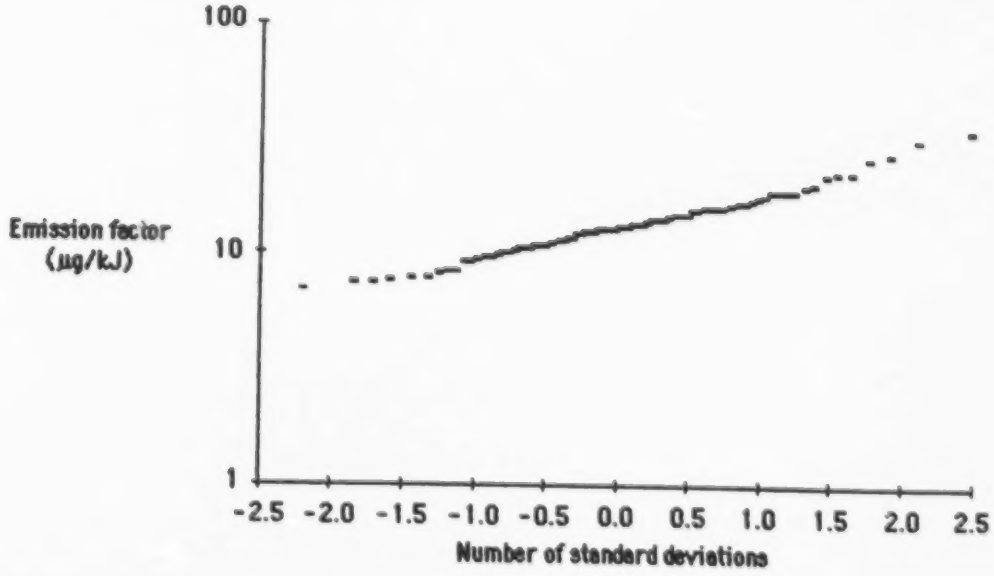


Fig. B-16. Log probability plot NO_2, all poorly adjusted combustion data.

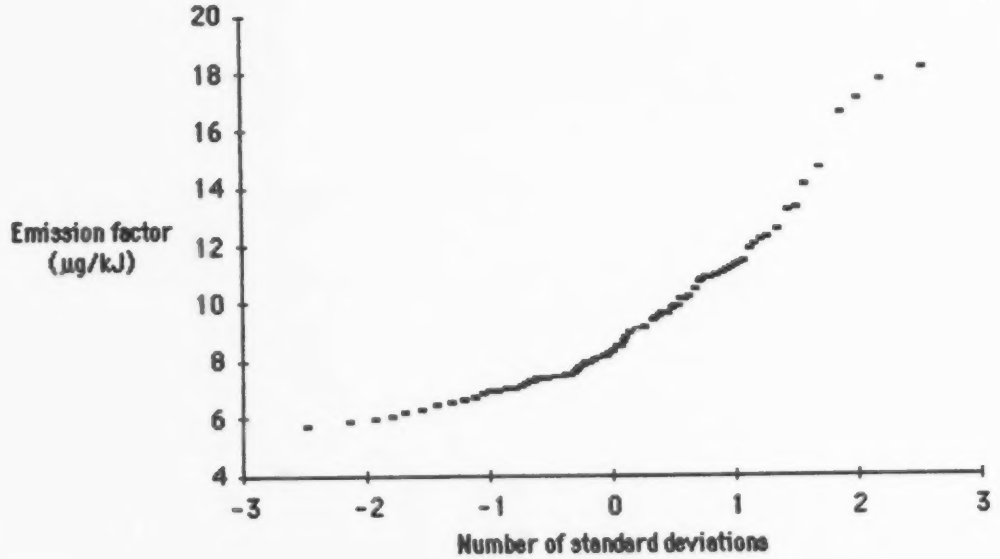
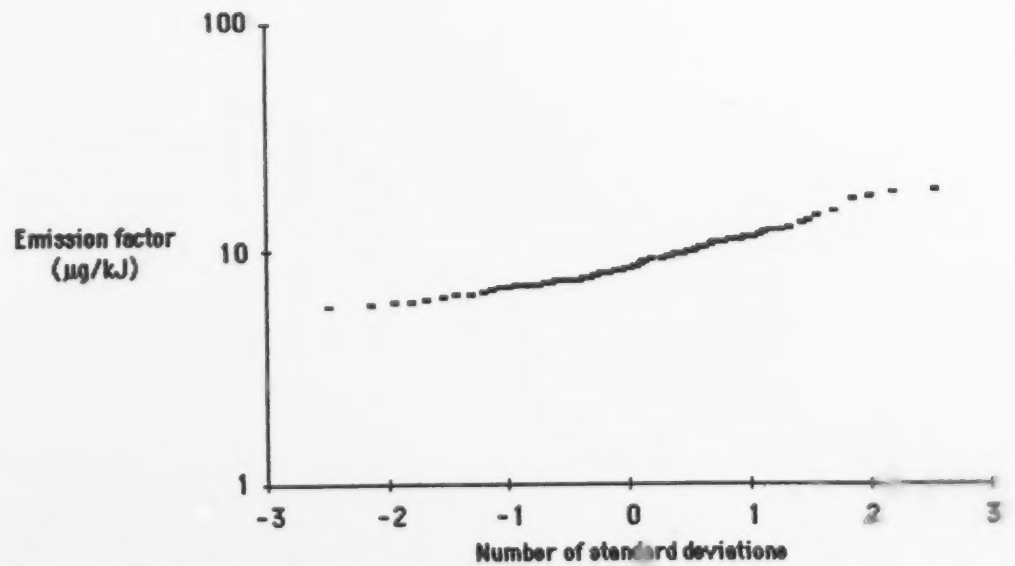


Fig. B-17. Normal probability plot NO_2, all well adjusted combustion data.



Fib. B-18. Log probability plot NO_2, all well adjusted combustion data.

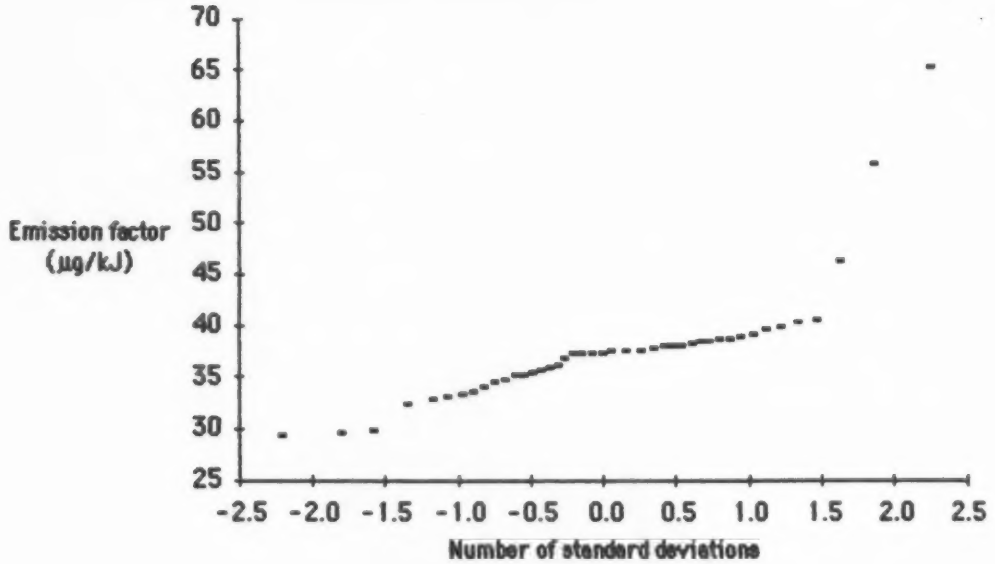


Fig. B-19. Normal probability plot NO_x, all data.

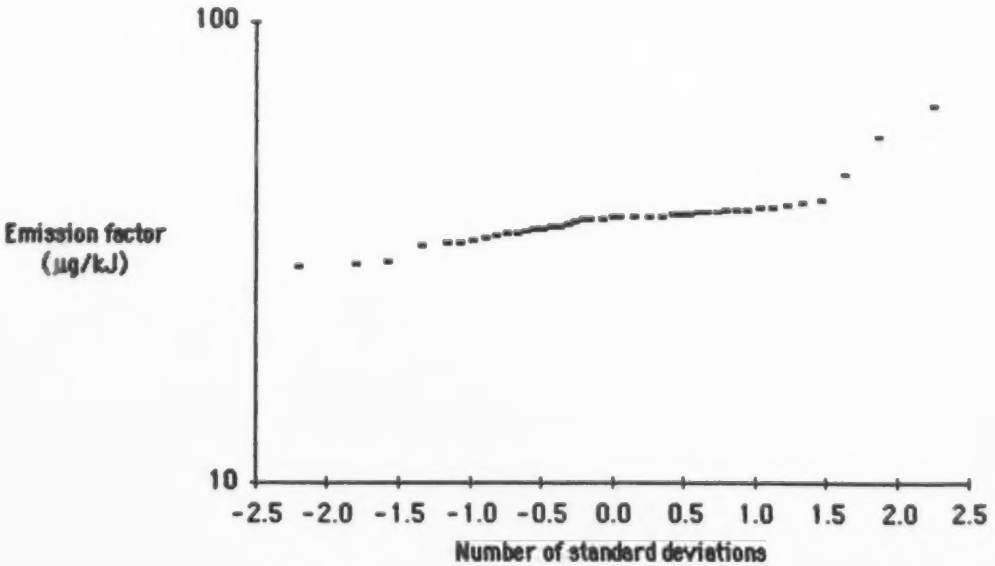


Fig. B-20. Log probability plot NO_x, all data.

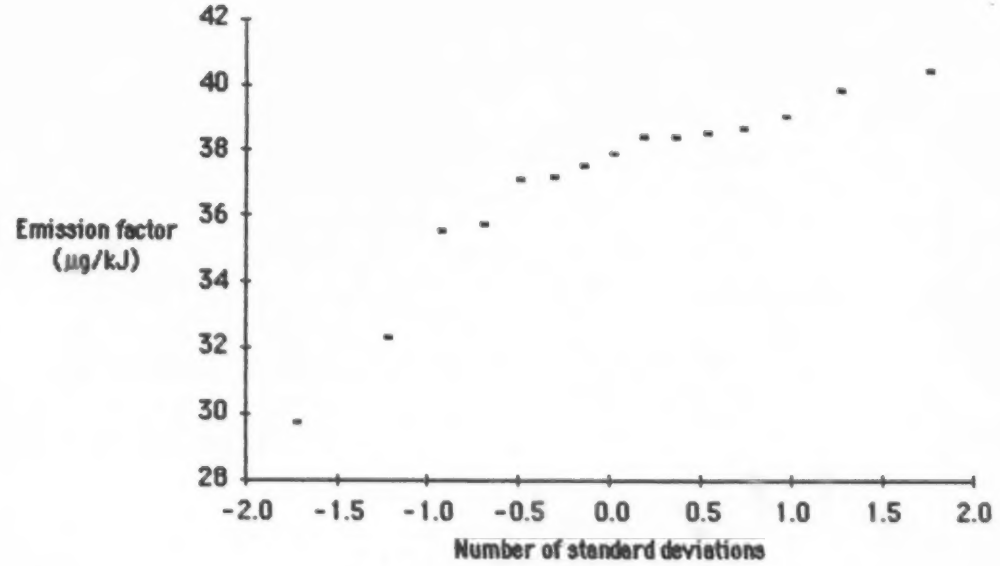


Fig. B-21. Normal probability plot NO_x, all poorly adjusted combustion data.

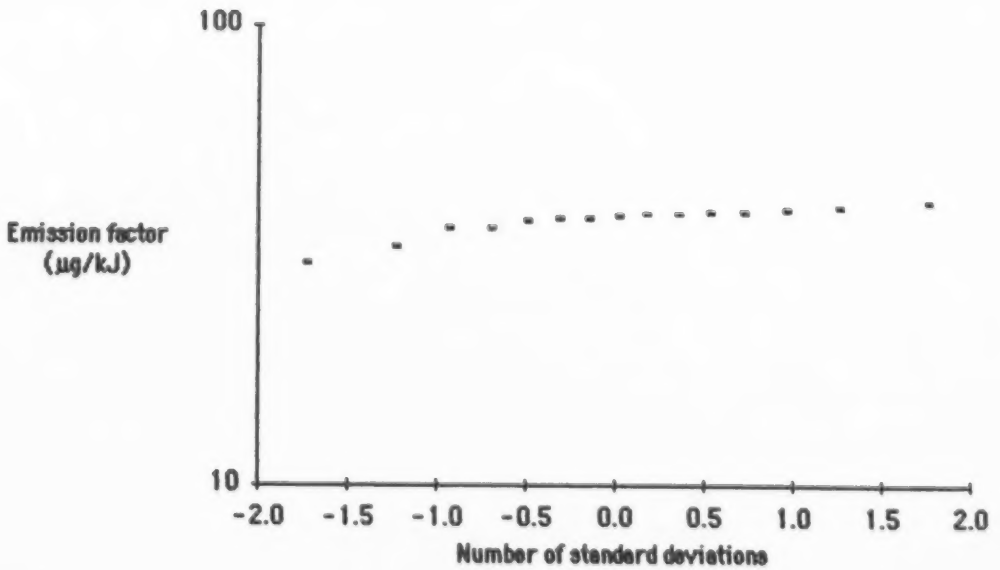


Fig. B-22. Log probability plot NO_x, all poorly adjusted combustion data.

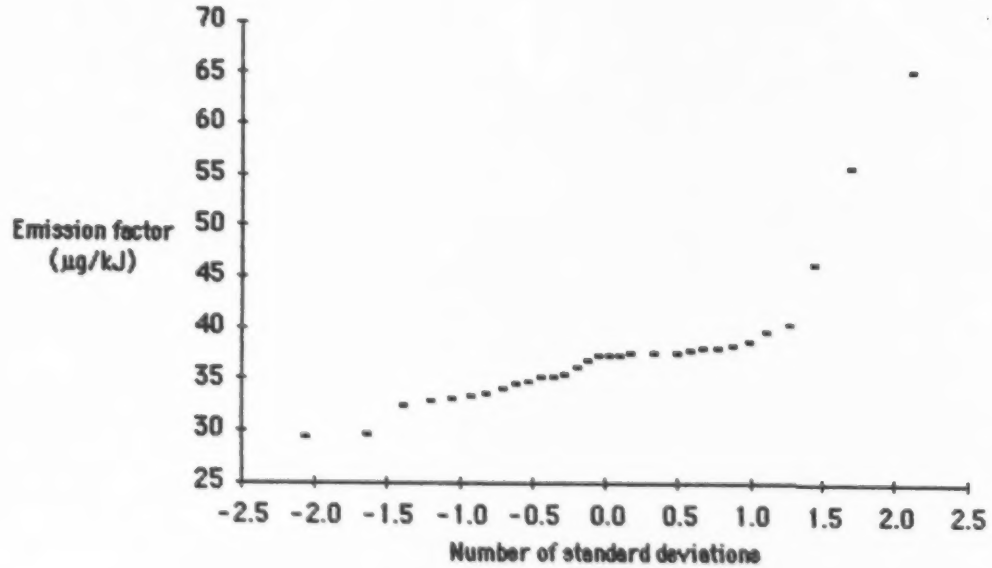


Fig. B-23. Normal probability plot NO_x, all well adjusted combustion data.

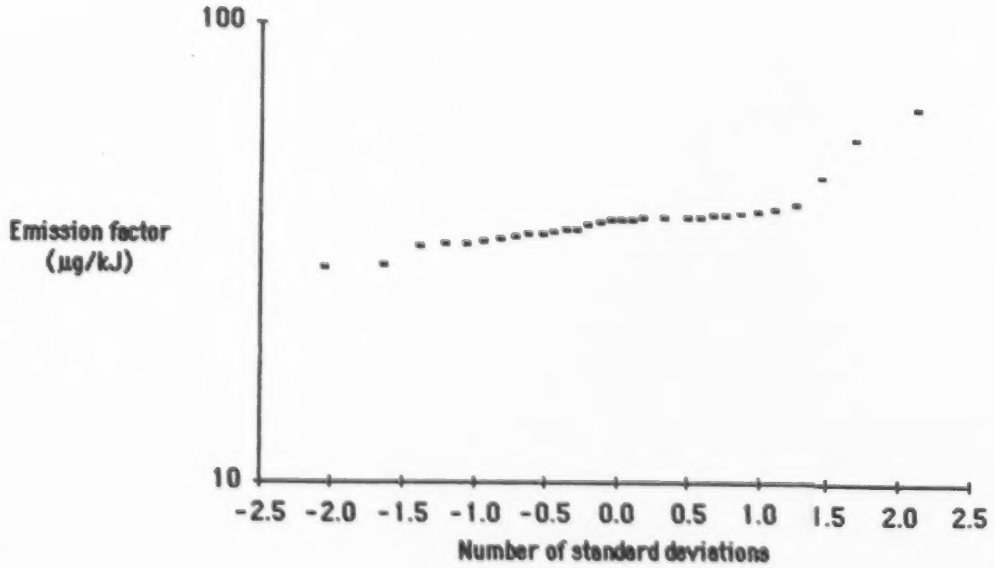


Fig. B-24. Log probability plot NO_x, all well adjusted combustion data.

Appendix C: Database for emission factors as a function of gas flow rate.

Column 1 - Reference number:

1 - Himmel and DeWerth (1974)
2 - Fortmann et al. (1984)
3 - Moschandreas et al. (1985)
4 - Borrazzo et al. (1986)

Column 2 - Gas flow rate: (kJ/min)

Column 3 - Emission factor (µg/kJ)

;CO EF(ug/kJ) vs. Igas(kJ/min)
#11

1	44	181.3
1	88	146.4
1	167	127.0
2	167	110.5
2	137	91.6
2	123	40.9
2	85	5.1
2	73	14.3
2	48	67.5
2	153	142.5
2	143	130.1
2	82	8.3
2	70	32.1
2	27	126.2
3	14	357.8
3	26	58.1
3	135	57.3
3	161	61.2
4	147.098	83.472
4	150.822	74.264
4	135.926	90.856
4	117.306	126.180
4	98.686	184.769
4	57.722	175.472
4	33.144	61.713
4	22.716	131.723
4	35.378	56.533
4	50.274	118.581
4	76.342	253.588
4	87.514	238.650
4	124.754	130.998
4	150.822	87.321
4	128.478	99.964
4	83.790	210.752
4	61.446	188.942
4	42.826	57.322
4	33.516	53.040
4	25.696	93.901
4	39.102	44.238
4	48.040	68.793
4	75.970	239.625
4	103.527	174.943
4	135.926	96.090
4	147.098	76.126
4	139.650	78.082
4	107.624	137.874
4	71.128	206.534
4	54.370	133.621
4	57.722	147.946
4	36.123	53.660

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4	25.323	111.742
4	35.006	55.633
4	40.592	69.258
4	61.446	202.502
4	63.680	211.477
4	92.728	226.361
4	124.754	138.118
4	149.332	85.445
4	147.470	74.290
4	132.574	88.557
4	111.720	127.938
4	80.438	195.029
4	44.316	56.774
4	31.393	56.514
4	19.961	147.398
4	31.095	44.400
4	45.060	50.464
4	63.308	256.020
4	75.970	225.596
4	88.259	203.130
4	102.038	166.735
4	138.533	89.922
4	148.588	65.802
4	145.981	85.160
4	126.616	97.952
4	102.038	157.343
4	77.832	212.264
4	45.805	47.202
4	39.102	22.673
4	24.132	75.629
4	17.242	201.042
4	27.520	54.277
4	36.495	26.658
4	52.508	100.270
4	70.756	212.121
4	85.280	221.851
4	108.741	151.732
4	139.650	85.905
4	148.588	73.706

;NO EF (ug/kJ) vs. Igas (kJ/min)
#12

1	44	1.45
1	88	9.41
1	167	22.46
2	167	12.36
2	137	13.30
2	123	11.40
2	85	11.14
2	73	9.24
2	48	3.41
2	153	14.02
2	143	15.15
2	82	12.7
2	70	8.17
2	27	2.68
3	14	0.86
3	26	9.90
3	135	13.35
3	161	14.64
4	147.098	17.7110
4	150.822	17.3111
4	135.926	18.4377
4	117.306	18.6839
4	98.686	17.2976
4	57.722	16.0689
4	33.144	17.1004
4	22.716	13.3336
4	35.378	16.4127
4	50.274	16.0195
4	76.342	15.0815
4	87.514	16.0825
4	124.754	17.4496
4	150.822	17.1240
4	128.478	17.9734
4	83.790	16.0670
4	61.446	15.6123
4	42.826	15.8390
4	33.516	14.4151
4	25.696	11.1387
4	39.102	15.0601
4	48.040	14.7414
4	75.970	15.2877
4	103.527	17.0628
4	135.926	18.1590
4	147.098	17.7111
4	139.650	18.4670
4	107.624	18.0229
4	71.128	15.9889
4	54.370	16.1693
4	57.722	15.6912
4	36.123	16.0720

4	19.961	28.2747
4	31.095	32.1638
4	45.060	34.7812
4	63.308	43.3590
4	75.970	38.7387
4	88.259	39.2454
4	102.038	40.2314
4	138.533	39.7988
4	148.588	39.7242
4	145.981	39.1811
4	126.616	40.2516
4	102.038	40.2509
4	77.832	38.4664
4	45.805	34.2548
4	39.102	28.7105
4	24.132	28.5659
4	17.242	20.2739
4	27.520	29.2664
4	36.495	30.9388
4	52.508	33.8337
4	70.756	[illegible] 5770
4	85.280	[illegible] 184
4	108.741	[illegible]
4	139.650	3.
4	148.588	39.

```
;NOX EF (ug/kJ) vs. Igas (kJ/min)
#14
3       14          15.93
3       26          23.25
3       135         28.85
3       161         29.28
4     147.098     39.2066
4     150.822     38.9629
4     135.926     39.3424
4     117.306     41.1096
4      98.686     40.6128
4      57.722     39.9151
4      33.144     38.8938
4      22.716     37.7445
4      35.378     37.5495
4      50.274     38.2566
4      76.342     38.3316
4      87.514     39.3623
4     124.754     38.7592
4     150.822     37.7332
4     128.478     38.9011
4      83.790     39.3677
4      61.446     38.9437
4      42.826     36.3470
4      33.516     33.5797
4      25.696     31.6796
4      39.102     34.7276
4      48.040     34.3344
4      75.970     38.3827
4     103.527     39.5667
4     135.926     38.8360
4     147.098     39.6634
4     139.650     39.5760
4     107.624     40.3802
4      71.128     39.7164
4      54.370     38.9971
4      57.722     38.4221
4      36.123     37.0657
4      25.323     35.7506
4      35.006     37.9803
4      40.592     41.6615
4      61.446     38.1339
4      63.680     37.9616
4      92.728     39.9018
4     124.754     39.4019
4     149.332     37.9709
4     147.470     38.8723
4     132.574     40.1681
4     111.720     40.0055
4      80.438     39.0666
4      44.316     36.0174
4      31.393     34.4237
```

4	25.323	16.1729
4	35.006	12.5924
4	40.592	14.1789
4	61.446	14.4841
4	63.680	14.9849
4	92.728	14.4497
4	124.754	12.3865
4	149.332	11.6834
4	147.470	12.9044
4	132.574	11.4096
4	111.720	12.6685
4	80.438	14.9296
4	44.316	12.3631
4	31.393	11.8685
4	19.961	17.8427
4	31.095	11.0877
4	45.060	11.8246
4	63.308	17.4369
4	75.970	15.3674
4	88.259	14.6742
4	102.038	13.9374
4	138.533	11.8316
4	148.588	13.7275
4	145.981	12.7627
4	126.616	11.6819
4	102.038	13.3736
4	77.832	14.7092
4	45.805	12.1127
4	39.102	9.8309
4	24.132	13.7635
4	17.242	17.3067
4	27.520	11.8438
4	36.495	10.1150
4	52.508	12.7190
4	70.756	14.4134
4	85.280	14.7256
4	108.741	12.6140
4	139.650	11.5425
4	148.588	13.2153

;NO2 EF (ug/kJ) vs. Igas (kJ/min)
#13

1	44	15.26
1	88	14.00
1	167	10.17
2	167	6.85
2	137	7.06
2	123	5.63
2	85	5.61
2	73	6.37
2	48	11.91
2	153	8.61
2	143	8.61
2	82	6.94
2	70	9.61
2	27	12.51
3	14	14.21
3	26	8.61
3	135	8.61
3	161	7.32
4	147.098	12.0947
4	150.822	12.4191
4	135.926	11.0712
4	117.306	12.4610
4	98.686	14.4447
4	57.722	15.0298
4	33.144	12.8918
4	22.716	17.2995
4	35.378	12.7828
4	50.274	13.6933
4	76.342	15.0267
4	87.514	14.7025
4	124.754	12.0032
4	150.822	11.5199
4	128.478	11.3419
4	83.790	14.3155
4	61.446	14.8902
4	42.826	11.8954
4	33.516	11.2641
4	25.696	14.3247
4	39.102	11.2775
4	48.040	11.5879
4	75.970	14.9415
4	103.527	13.4682
4	135.926	10.9438
4	147.098	12.5512
4	139.650	11.2124
4	107.624	12.6819
4	71.128	15.1020
4	54.370	14.2042
4	57.722	14.2395
4	36.123	12.6224

4	25.323	12.7681
4	35.006	16.6898
4	40.592	17.8093
4	61.446	15.2762
4	63.680	15.1296
4	92.728	16.5992
4	124.754	17.7580
4	149.332	17.2009
4	147.470	16.9079
4	132.574	18.7556
4	111.720	17.8284
4	80.438	15.7415
4	44.316	15.4168
4	31.393	14.6249
4	19.961	6.8035
4	31.095	13.8306
4	45.060	14.9814
4	63.308	16.8375
4	75.970	15.2421
4	88.259	16.0247
4	102.038	17.1482
4	138.533	18.2395
4	148.588	16.9544
4	145.981	17.2294
4	126.616	18.6324
4	102.038	17.5287
4	77.832	15.4938
4	45.805	14.4893
4	39.102	12.2785
4	24.132	9.6350
4	17.242	1.9351
4	27.520	11.3299
4	36.495	13.5195
4	52.508	13.8546
4	70.756	13.8643
4	85.280	15.5366
4	108.741	16.8859
4	139.650	17.9058
4	148.588	17.0558